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COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF AGRICULTURE

BULLETIN No. 250

SOILS OF PENNSYLVANIA

BY

FRANKLIN MENGES, Ph. D.

A Statement of the Origin and Capacity of the Soils of Various Counties, including a Discussion of the same by Townships, of the Counties East of the Allegheny Mountains, together, with Suggestions of their Adaptation to the Different Crops Grown

PART ONE

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PREFACE

Every business man needs to have as full and accurate knowledge of his assets as is possible. To carry on his business without such knowledge would be hazardous. The wise King of Israel declares, "The prudent man looketh well to his going;" hence we note the care with which men possessing the true business instinct make their regular accounting of stock.

The farmer's principal asset is his soil, and it is for the purpose of turning his thought in this direction and to encourage a more careful study of the subject, that this report upon the Soils of Pennsylvania has been prepared.

The Soil Survey, recently taken up by the Federal Government, has the approval of the general public, and its reports are receiving the attention of intelligent farmers and students of Agriculture in all sections of the country; but to cover the whole country within a reasonable time is a work of such magnitude that the survey made of the soils of any particular state is necessarily limited. It was thought, therefore, that having so great a variety of soil formations in Pennsylvania, containing so widely different characteristics, it would be well to have a closer survey made, and the report being too voluminous to be contained in one volume, has been divided into two parts, and the respective counties so grouped that Part I will be suited to one section of the State and Part II to the other.

A. B. Critchfield

Secretary of Agriculture.

L317502

LETTER OF TRANSMITTAL

York, Pa., March 16, 1914.

Hon. N. B. Critchfield, Secretary of Agriculture, Harrisburg, Pa.

Dear Sir:

I herewith transmit to you the manuscript of the bulletin on the soils of Pennsylvania, their origin, capacity and adaptation, together with a discussion of origin of soils and the climatic conditions prevailing throughout the State. I would suggest that this bulletin be divided into two parts, Part One, including all the counties east of the Allegheny Mountains, and Part Two, all the counties west of these mountains. This is a natural division, the former embracing all the areas of the Lower and Upper Silurian and Devonian ages with the exception of small areas, such as the Broad Top region in Huntingdon, Bedford and Fulton counties, the Anthracite region in Dauphin, Schuylkill, Northumberland, Carbon, Luzerne and Lackawanna counties, and small patches in Sullivan, Bradford, Tioga, Clinton and Potter counties, where the mountain flattens and small patches of the Carboniferous Age remains, while west of the Allegheny Mountains all the counties belong to this latter age.

I would further suggest that Part One include the following counties: Philadelphia, Delaware, Chester, Lancaster, York, Adams, Franklin, Cumberland, Dauphin, Lebanon, Berks, Lehigh, Montgomery, Bucks, Northampton, Fulton, Bedford, Blair, Huntingdon, Center, Clinton, Lycoming, Mifflin, Juniata, Snyder, Union, Perry, Northumberland, Montour, Columbia, Schuylkill, Carbon, Monroe, Pike, Luzerne, Wyoming, Lackawanna, Wayne, Susquehanna, Sullivan, Bradford and Tioga.

Part Two: Potter, McKean, Warren, Erie, Cameron, Elk, Forest, Venango, Crawford, Mercer, Clearfield, Jefferson, Clarion, Cambria, Indiana, Armstrong, Butler, Lawrence, Beaver, Allegheny, Somerset, Westmoreland, Fayette, Washington and Greene.

Yours very truly,

FRANKLIN MENGES.

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FOREWORD

The purpose of the bulletin is to bring to the farmers, a plain and simple statement of the soils of the various counties and townships, as well as localities in townships throughout the State, giving the origin, capacity and adapation of the soils of the various sections. No effort is made at scientific discussions, and all terms with which the average farmer is not familiar, in so far as possible, have been eliminated and plain, simple statements to convey the ideas intended have been used. The natural methods of soil improvement have been advocated, that of having a growing plant on the land at all times, and in so far as possible, a soil improving plant instead of a soil exhausting one. These crops have been advocated in numerous sections in which they have never been raised; but from the examination of the soil and the prevailing climatic conditions, the author is convinced, after the soils have been improved by raising and plowing down, or better still feeding the less exacting leguminous crops such as sweet clover; or the cowhorn turnip and other less exacting varieties of the root crops, and rye among the cereal grains, and applying the manure, the land will produce the more exacting fall and spring sown, long and short season legumes as well as the more exacting root and cereal crops.

The livestock industry, with all its accessories, dairying, the production of beef, lamb, mutton and wool, but especially pork, wherever soil, climatic and market conditions justify such undertakings together with the arrangements of rotations for raising both the leguminous and cereal crops for feeding the animals to yield the largest returns as well as for producing the largest quantity of manure and other roughage to be returned to the soil, to maintain and increase its fertility, are advocated. That there are soil and climatic conditions under which crops are produced, especially suited for certain phases of the livestock industry, is well illustrated in the southwestern and western sections of the State where the Blue grass pasture will produce a superior grade of wool and more vigorous, stronger boned horses than in any other section of the State. Such soil and climatic conditions should be utilized wherever possible. Little is said about the uses of artificial fertilizer and lime because the Department has issued several bulletins on the uses of these materials to which the reader is referred.

It might be added, that wherever the methods here advocated that of having a growing crop on the soils at all times and using the manure as it is made or improving it by storage and plowing down

heavy sods, and after the farmer has learned how to produce and maintain a congenial environment for nitro-gathering bacteria in the soil and how to control toxic substances or conditions in the soil; artificial fertilizer or soil improving substances will be used as correctives and not promiscuously as they now are without a definite knowledge of what they accomplish in the soil. It must be understood that all discussions are necessarily general and limited because a detailed discussion would be inconveniently voluminous. The geological data were taken from the reports and maps of the Second Geological Survey of Penna. by Dr. J. P. Lesley in so far as these were accessible, and personal examinations of all the soil areas of the State were made by the author. Hon. Geo. S. Bliss, Director of the Weather Bureau, Philadelphia, prepared the charts and maps giving the normal annual precipitation throughout the various sections of the state for twenty three years, the dates of the first killing frosts in fall and the last in the spring, the spring, summer, fall, winter and annual mean temperatures, which is probably one of the best pieces of work done for the agriculture of the State in years and for which the author hereby publicly expresses his thanks. His thanks are also due to the U. S. Geological Survey, the Bureau of Soils of the U. S. Dept. of Agriculture, for the soil survey of the State as far as they were available, and to Mr. W. H. Stout of Pinegrove, Schuylkill county, for valuable suggestions and assistance in a number of counties, as well as to many others all of which he hereby acknowledges. The historical data were taken from William Egle's History of the Commonwealth of Pennsylvania, and the Census data from the 13th Census of the United States.

FRANKLIN MENGES.

ORIGIN OF SOILS

The soils of Pennsylvania will be discussed in these pages, not as the inert remains of disintegrated rock and previous vegetation, but as an accumulation of these materials in which the process of formation, alteration, transportation, solution, deposition, oxidation, reduction, chemical interaction, fermentation, digestion or decay, such as takes place in the animals and plants producing similar compounds in the organic matter of the soils as are produced by these processes in plant and animal life are still going on and always will be.

This soil is the medium by which the farmer, through the capacity of the leaves of the plants, catches the sunlight or the energy, as Dr. Armsby says, which operates the bodily mechanism, and upon the regularity and sufficiency of which the energy supply for all human endeavor absolutely depends. The construction of the soil was brought about by the energy of the sun. The first soil was the solid rock which was disintegrated through agencies that likely do not now exist as they then did, but the soils of the present day that have been and are being formed come into existence through the energy of the sun. The sun rays strike the solid rock like innumerable little hammers and cause the rock to become heated, and the heat causes expansion amounting to at least *an inch in each 100 feet of diameter during the variations of temperature such as occur in this State. This expansion and contraction caused by the rising and falling of temperatures has been great enough to cause the chipping of the rocks of hills and mountains and breaking these down; and where this has not been the case it has caused the formation of little cracks and crevices to afford a starting point for other agencies of disintegration, such as water, to break down the rocks. The rays of the sun when they fall upon water, warm the water as they do the rock, but unlike the rock the water changes into a gas or vapor, which, on account of it being lighter than the air about it, rises until it reaches such an altitude and such conditions that the particles of vapor again combine and form larger and larger particles or drops of water, and these fall in rain either upon the rock or on the sea and ocean, and if on the rock the rock absorbs a certain amount of the water, depending upon its structure and character. Granite rock may take up about 0.4% of its weight, marble 0.3%, lime stone 0.5% to 5.0%, chalk 20%, and sand stone variable amounts up to 10% or 12%. When this water becomes heated in the rock from the pelting of the sun's rays it expands in a similar way, as if it were heated in the boiler of a steam engine, and we well know what power such expansion exerts.

*Prof. N. H. Shaler.

But water has another capacity, that of expanding when it freezes and for this reason ice floats; were it not for the expansion of water upon freezing, our streams would freeze in all directions, and the summers would not be long enough to thaw them. A cubic foot of water when it freezes increases to 1.0908 cubic foot or it increases approximately one inch in size. Any rock or soil containing a cubic foot of water will when the water freezes be forced to expand to the same extent as would the cubic foot of water were it freezing without the rock. This expansive force of water when it passes from the liquid into the solid state is equal to a pressure of about 150 tons of ice to the square foot. After the rock has absorbed all the water it can hold the remainder flows over the surface whether horizontal or inclined, and if any of the rock has been disintegrated the water carries at least part with it, and this causes sedimentary accumulations until these become so vast and heavy that the pressure is sufficient to harden this sediment into rock, and sedimentary rock is formed out of the materials of which the original rock was made.

Flowing water is the great agency by which the materials are carried and laid down and sendimentary rock is formed, as already indicated. This water, brought by the sun in contact with the rock, does not only act by expansion and contraction in breaking up the rocks, and as a transporting agency, but it acts chemically, first, as a solvent of the rock, second, through the oxygen it dissolves out of the air, and brings both this and the oxygen chemically held in water into the closest contact with the rock materials. A good illustration of the greater activity of oxygen when dissolved in water or when acting through water as a solvent, is furnished when a highly polished iron implement such as a saw is allowed to lie in the rain and become wet by rain water it will rust quickly; whereas, the same implement could be allowed to be in contact with dry oxygen for a considerable time without any effects being noticeable. Third, as a deoxidising agent by taking oxygen away from the rock. Fourth, it acts as a hydrating agent by the water combining with some of the minerals of which the rock is composed, and forming so called hydrates.

The first of these as already indicated is solution. That the everlasting rocks are slowly going into solution or are being dissolved by water is evident from the amount of crust or solid materials that accumulate in vessels continuously used for heating water, and water, too, in which not a particle of solid matter could be seen even by the use of a microscope. This is true of water from wells and springs or water taken from streams and entirely clarified. Another thing, the mineral elements and minerals dissolved in the water are the same as those of which the rock over and through which the water flows are composed. It has been estimated from the

quantity of lime held in solution by water in the limestone regions of the Appalachian system, that 275 tons of limestone is dissolved annually in every square mile of such limestone formation. Similar estimates have been made for other minerals, such as magnesia, silica, etc. The water does not only take these minerals into solution, but it acts chemically on them or changes their composition so that they are more readily soluble.

The agencies by means of which these chemical changes are brought about are the gases held in solution by water, such as carbonic acid and oxygen, nitrogen and small quantities of the oxides of nitrogen. The effects of carbonic acid gas on limestone can readily be demonstrated by blowing the gases from the lungs through a piece of any kind of tubing into a glass of clear lime water. If the lime water is clear it will become cloudy or milky at first, but after continuous blowing for several minutes the lime water will become clear, whether clear at first or not, showing that something in the gases from the lungs has acted on the solid or the limestone formed in the limewater, by the gases from the lungs, and has put it into solution. This gas is carbonic acid, also known as Carbon dioxide. This gas does not act on limestone only, but on well nigh all even the most resistant minerals and is more effective when dissolved in water, than when in the gaseous conditions.

Carbon dioxide is not the only gas brought by water in contact with and into the rock, but oxygen, another of the gases of the air, is also dissolved in rain water and carried by it into the rock, and because of its being brought into such close proximity to the constituents of the rock, it acts more readily as well as more efficiently in changing the minerals of which the rock is made up by combining with these (No. 2). In this way the red ochreous soils in the micaceous shist formation in southeastern Pennsylvania were produced and are being produced now when the shistose rocks are decomposed. By the oxygen combining with the minerals of which the rock is composed, unless the substance so formed is carried away by solution, increase the bulk of the rock and in this way causes a strain that helps to disintegrate it. This action goes on to a far greater extent than investigators have been giving it credit.

Deoxidation or the taking away of oxygen as the rock is disintegrated, likely takes place in the Carbonaceous shales and where rock is decomposed under water. Hydration usually takes place at the same time as oxidation, in fact, it seems that the two are inseparable, in igneous rock disintegration, by water carrying oxygen in solution. After this combination of water with the minerals of the rock has begun, it seems to become contageous and vast sections of rock are disintegrated to a depth of many feet; whereas, other places in the same territory with the same rock little or no disintegration has

taken place. This kind of disintegration has been going on in the Syenite rock in the vicinity of Gettysburg, on parts of the Battlefield, where the very form of the original rock can still be seen, but has become so completely disintegrated that the residuum can be spaded with an ordinary shovel. Another place where this disintegration of Syenitic rock by hydration has taken place but has not proceeded to a complete unlocking of all cohesion occurs on the Harrisburg road about five miles north of Gettysburg. Here, boulders covered with disintegrated rock, retain their shape and when first exposed seem comparatively hard, but when struck with a hammer, instead of a clear ringing sound, give only a dull thud; and when exposed to the action of the atmosphere, especially freezing temperatures, soon fall to pieces showing that these stones had become rotten. The same thing has taken place in the Potsdam sand formation on Shunk's Hill, south of York and at Newman's sand quarry, east of York, near the N. C. R. R. Here the formation remains stratified and the rock apparently hard but when exposed soon, like the Syenite, swells slightly and changes into a gritty sand.

During the process of hydration, though taking place at an exceeding slow rate, the rock expands, which, after hydration has gone on to a sufficient extent, causes the distintegration of the rock, as was the case with the Syenite and the Potsdam sand. That hydration exerts a tremendous force is evident in bricks made of limestone clay in which small pieces of undecomposed limestone get into the bricks which when these are burned, the carbonate of lime is changed into the oxide of lime, and when the brick absorbs water, the lime becomes hydrated and expands with sufficient force to cause the hardest bricks to scale off or break. Water slacking lime is a process of hydration, and all farmers who have slacked lime know that some limes during the process of slacking increase to well nigh twice their original bulk. Whatever may be regarded by investigators to be the most potent agency of disintegration, it appears that hydration is the most desirable because, according to what has been said before, these stones or rock retain their original structure, though disintegrated, and with that structure they also retain approximately all components and the desirable elements of fertility, according to the following three analyses: The first, that of a fresh gray granite, second, a moderately firm but partially disintegrated rock but retaining its granitic appearance, and, third, the rock completely disintegrated but in position where this process took place.

Constituents	I	II	III
	%	%	%
Silica $Si\ O_2$	69.33	66.82	65.69
Titanium,	not det.	not det.	0.31
Alumina,	14.33	15.62	15.23

Iron protoxide,	3.61	1.69	.....
Iron sesque oxide,	.....	1.88	4.39
Lime,	3.21	3.13	2.63
Magnesia,	2.44	2.76	2.64
Soda,	2.70	2.58	2.12
Potash,	2.67	2.04	2.00
Phosphoric acid,	0.10	not det.	0.06
Lost on heating,	1.22	3.27	4.70
Total,	99.60	99.79	99.77

A glance at these figues will show that there is a suprising small difference in the composition of the original granite, the partially and the completely disintegrated rock. There is a slight decrease of silica, lime, magnesia, potash and soda, with a small increase of alumina and a considerable increase in the amount of water. It must not be assumed that the particles of residual sand have all been disintegrated and lost their original composition, for it was found upon examination that many of them still retain their mineral identity. But others, especially the alumina, has changed to the hydrous silicate of alumina. In this slow but persistent hydrating process the rock has disintegrated. After this disintegration has proceeded to such an extent that the rock will fall to pieces or can be spaded with a shovel, except under extreme pressure, the water of hydration will be given up.

Another example of decomposition of the original igneous rock is that of phonolite:*

Constituents	Fresh Rock %	Decomposed Rock %
Silica,	55.67	55.72
Alumina,	20.64	22.19
Ferric oxide,	3.14	3.44
Lime,	1.40	1.28
Magnesia,	0.42	0.44
Potash,	5.56	6.26
Soda,	7.12	2.65
Loss on ignition,	4.33	7.79

There is little loss in this disintegration except a considerable percentage of the soda with approximately as large a gain in water. No phosphoric acid occurs in this rock and soils derived from it as well as from those previously given must be deficient in that element of fertility, which, in soils of this kind or formation, must be supplied. It must be recognized, however, that after disintegration has proceed-

*Merrill, Rocks and Rock Weathering. Pages 186 and 198.

ed to such an extent that the rock is converted into its mineral constituents the greater the quantity of the elements of fertility carried away, as the following analyses will show:

WEATHERING OF BASALTS

Constituents	Fresh Rock %	Partially and %	Further Disintegrated %
Silica, ...	43.61	43.00	43.27
Alumina, ...	12.26	13.90	18.13
Ferric oxide, ...	3.51	4.50	11.70
Ferrous oxide, ...	12.16	8.30	.....
Lime, ...	11.37	12.10	2.60
Magnesia, ...	9.14	7.30	3.40
Soda, ...	2.72	0.50	0.20
Potash, ...	0.81	.....	.....
Water, ...	4.42	9.50	20.70
Total, ...	100.00	100.00	100.00

As already indicated, hydration is here one of the first stages of disintegration which evidently first effected feldspars because the silica diminishes slightly and the soda and potash well nigh completely disappear, which is further illustrated by the oxidation of considerable of the iron and the disappearance of some of the magnesium and the iron, all of which elements in this case enter into the composition of these first disintegrated. In the third stage of decomposition the iron changes entirely into the most undecomposible condition, and lime decreases from 12.10% to 2.60%, magnesia from 7.30% to 3.40%, and alkalies from 0.50% to 0.20%. This same disintegration is going on in this original rock today as it did at all times, probably not at the same rate but still it is going on and the farmers who till these soils have a more definite knowledge of what their soils contain than the farmers whose soils are sedimentary in character because as appears from the analyses when these rocks have become partially disintegrated and when they are in such a condition that plant roots can penetrate them they contain a large percentage of the essential plant foods contained in the original rock. This is not true of sedimentary soils and not as true of soils formed from sedimentary rock.

SEDIMENTARY ROCK

As already indicated, sedimentary rocks were formed from the materials resulting from the disintegration of the igneous or primeval rock and are, therefore, made up of the materials little acted on by the agencies that caused the disintegration of these rocks, or of the

materials completely dissolved by the action of these agencies of disintegration, such as water, together with the gases it contains from which these substances, such as lime, were again extracted through the operation of organisms and deposited in immense beds of limestone in many sections of the State. These sedimentary rocks, covering well nigh all of Pennsylvania, are at the present time undergoing disintegration either through mechanical agencies or by the chemical action described. Limestone and the rock held together by a lime or Feldspathic cement are nearly all disintegrated by chemical action, while the greater part of the rest are broken down by mechanical action.

The following analyses of a fresh argillite from Hardford Co., Md., evidently containing considerable quantities of not completely disintegrated silicates, and therefore the chemical agencies of disintegration became operative, gives some idea of what happens when this early form of sedimentary rock again disintegrates and forms soil or residual clay:

Constituents	Fresh Rock	Residual Clay	Lancaster County Roofing Slate
	%	%	%
Silica, ...	44.15	24.17	60.15
Alumina, ...	30.84	39.90	24.20
Iron oxide, ...	14.87	17.61	7.65
Lime, ...	0.48	.....	.....
Magnesia, ...	0.27	0.25	.....
Potash, ...	4.36	1.24	
Soda, ...	0.51	0.23	4.27
Ignition, ...	4.49	16.61	3.72
Total, ...	99.97	100.02	99.99

The first analyses represents the fresh rock, and the second column that of the residual clay, and the third column that of Lancaster County roofing slate, which, if it had been disintegrated as the one from Maryland, would, in all probability, furnished a similar residual clay or soil. Another series of early sedimentary rock distintegrated by chemical agencies are the limestone formations such as the Cambrio Silurian, Helderberg, and others which underlies vast areas of Pennsylvania. This disintegration usually leaves a rich red clay soil, such as are found in parts of Chester, Lancaster, York, Adams, Cumberland, Franklin, Dauphin, Lebanon, Berks, Lehigh, Northampton, Huntingdon, Center, Blair, Bedford, Somerset, and smaller areas in

several other counties. These soils contain only the least soluble constituents of the original rock as the following analyses of a sample of this old magnesia limestone formation will show:

Constituents (No. 5)	Fresh Rock %	Disintegrated Rock %
Silica,	7.41	57.57
Alumina,	1.91	20.44
Iron oxide,	0.98	7.93
Lime,	28.29	0.51
Potash,	1.08	4.91
Magnesia,	18.17	1.21
Soda,	0.09	0.23
Carbon dioxide,	41.57	0.39
Phosphoric acid,	0.03	0.10
Water,	0.57	6.69

From these and many other agencies of disintegration not mentioned here we see how the original igneous rock was broken down, and again by continuous accumulations rebuilt into sedimentary rock and then by the infinite cycles of change converted into a soil upon which the immense plant life from which the coal measures of this and other states were derived was produced. From then to the present time plants and animals have been engaged in taking up and holding a share, however small, of the energy of the sun which falls in such infinite quantities daily upon the surface of this earth, that each square foot receives annually an amount of heat which, if it could be utilized in a theoretically perfect heat engine, would hoist nearly one hundred tons to the height of one mile. To get and hold this for developing a higher and higher plant and animal life, plants have come into existence adapted to soils ranging from the barren rock to soil so fertile that a plant life so luxuriant was produced that fertility is not the limiting factor but sunlight and rain.

SOIL FORMATIONS REPRESENTED IN PENNSYLVANIA

The State of Pennsylvania represents a greater diversity of soil formations than any state in the North Atlantic Division. She includes considerable areas of soils formed by the disintegration of igneous rocks in the southeastern counties. Here also occur the soils derived from the Metamorphic rock, the Micaccous, the Chlorite shist, the Hydro-mica shist, the Postdam sand, the Cambrio Silurian limestone, the Chazy formations, then the Trenton limestone, the Hudson river series, the Utica shales, the Uneida and Medina sands, while farther north and west the Clinton, Niagara and Salina shales,

(No. 5). Merrill, page 219.

the Lower and Upper Helderberg limestone, the Oriskany sand, the Marcellus, Hamilton, Genesee, Portage and Chemung shales, the Catskill red sand, the Pocono sand, the Mauch Chunk red shales, and the Pottsville conglomerate come in, and after these the coal measures, which comprise the lower productive, the lower barren, the upper productive and the upper barren measures with their limestone, sandstone and shales, covering the western area of the State.

Then coming back to the oldest formation, we have the Mesozoic sand laid down on top of the trap and Cambrio Salurian limestone, and in some places on the Potsdam sand formations. Later than this in the western, northwestern and northern counties of the State come the potters and fire clay and sands, Post Tertiary, the terminal Moraines and alluvial soils. Upon these formations, in many places so intermingled, that it is difficult to tell which predominates. Nature began producing crops which continued for ages until, in many places as already indicated, the fertility was so highly developed and the crop yield so luxuriant that the struggle between the plants was no longer one for fertility but for sunlight.

A CONSTRUCTIVE AGENCY

From what we have seen, it is evident that the first soils came into existence upon the disintegration of rock by atmospheric agencies, the physical, solvent and chemical action of water all directly traceable to the energy of the sun. The action of the gases such as Carbon Dioxide and Oxygen held in solution by water is invariably more pronounced on the minerals containing one or more of the elements that form compounds soluble in water or compounds made soluble by the action of the gases held in solution by water than upon elements not so affected. The feldspar minerals known as Potash Feldspar, Soda Feldspar, Soda-lime Feldspar, Lime-soda Feldspar, Lime Feldspar contain elements such as potash and lime essential to plant growth, readily acted on by water or the gases held in solution in water and converted into soluble compounds. Wherever this operation has begun plant life such as algae and lichens, and mosses will appear to take up and put into organic compounds these essential elements of plant food and hold them until the agencies of decomposition have converted them again into available plant food. Here decomposition and disintegration begin to work together, the former a chemical action the latter evidently a vital one.

These plants have appeared under well nigh all climatic and soil condtions and we have, as Warming shows in his Ecology Page 136, 1, vegetation growing on water covered soils or formations in water; 2, vegetation in marshes; 3, vegetation on soils that are comparatively dry but too wet for organic matter to decompose, which therefore makes sour soils and produces acid soil vegetation;

4, cold soil vegetation; 5, saline soil vegetation or the vegetation of salt marshes; 6, rock vegetation, already referred to; 7, vegetation on course sand or broken rock; 8, vegetation on soils in very dry climates; 9, vegetation on Savannahs; 10, bush and forest formations; 11, complete forest formations, and 12, formation ready for agricultural plants.

It is evident that well nigh all of these types of vegetation prevailed in the various sections of this State from the earliest elevated soils which were formed upon the uplift of the Appalachian Mountain system, which began in early Cambrian time and terminated at the close of the Carboniferous Age, and are now engaged in doing over and over what they and their more primitive ancestors have done in the ages past, during which likely more soil was formed in this mountain system than still remains. During all these ages as at the present time there occurred flat or rolling rock formations, rocky slopes with numerous declivities and chasms, at different angles with northern, eastern, southern and western exposures with hard rock and soft rock, rock of various composition, rock easily acted on by atmospheric agencies, rock not so readily acted on by these agencies, rock over which water slowly trickles, rock bathed in burning sunlight, rock in the shaded gully, rock exposed to the prevailing winds, and rock sheltered from these. Under such conditions a variegated rock vegetation occurs each one specially adapted to its environment but each slowly or more quickly working for the same purpose, that of soil construction.

These lowly plants, called Lithophites or rock plants, include algae, lichens, and mosses (No. 6) are dependent on each other for support, one supposed to furnish mineral nutriments by means of roots or rhizoids, another water, and still another, carbonic acid from the air with such a co-operative equipment these lowly organisms together with the agencies already described have been and still are at work on the everlasting hills and mountains, some the lime-loving varieties on the limestone, others the silica-loving kinds on granite trap sand stone, etc. The limestone formations being more readily acted on by atmospheric agencies, are more easily and completely colonized by these lowly plants, because upon these the lichens can fasten their rhizoids and the algae their filaments and assists the atmospheric agencies in their disintegrating operations and soon prepare a soil for more highly organized species, the earlier of which are mosses and fructose lichens which retain more and more of the essential elements of plant food obtained from the rock and more and more moisture and accumulate a larger and larger quantity of organic matter until club mosses and ferns find a congenial soil environment and establish themselves. The closer the rock formation approaches the flat or horizontal position the more perfect and

(No. 6). Mosses and Lichens, Nina L. Marshall.

extensive will the soil formation develop, whereas, if the rock formation be more or less steeply inclined and the atmospheric agencies of disintegration have started their work and the lichens and mosses have fastened themselves and have started the accumulation of organic matter, and small quantities of soil are formed it will be washed into clefts of smaller or larger dimensions in horizontal or flat spaces, and here in a shorter time because of the faster accumulation of the soil will be produced a plant life similar to that on the rock lying flat.

Another species of plants with long roots and long creeping rhizomes establish themselves upon the talus of hill and mountain sides extending these down through the crevices of the talus and extract mineral nourishment and with the same organs when partially or completely covered by a fallen talus reach out and again rise into the sunlight, in this way making a deeper and more extensive root system furnishing more fertility and moisture and sunlight so that the adversities that would destroy agricultural plants work together for good to these pioneer soil makers.

COLD SOILS

Cold soils are cold because of location such as the soils in northern regions and on high mountains. These soils produce a dwarfed plant life especially adapted to an environment in which there may be frost or snow any day or night during the growing season. Similar climatic changes prevail in the Torrid zone going up a mountain side as takes place going north from the Equator, but the plant life on the snow capped mountains here differs from the plant life on the mountain in the Temperate zone, which is similar to that of the Arctic regions because, in the former case, there is a little change in the temperature, wind, rain and amount of sunlight on top and at all points on all sides of the mountain as there is on the plain at the base; whereas, in the Arctic region there is a long day and a long night, and in the Temperate zone the rays of the sun are so slanting during half the seasons that their effects are similar to that in the Arctic regions, and consequently the plant life is similar.

SAND VEGETATION

The vegetation that first appears and adapts itself to sand and gravel such as occurs on the slowly moving sand dunes on the lee side of Lake Michigan are some of the sandworts followed by milkweed and the scouring rushes. These and many others produce sufficient organic matter, that within a few years, the lee side becomes overgrown with shrubs and trees which finally produces a forest in which poplar, oak, ash, sassafras, and even walnut and other trees grow. The vegetation on the sandy soils of some of the

Atlantic Coast states passes through a similar evolution, with species adapted to the environment until a soil sufficiently rich is produced and these sands become clothed with pine forests.

SOILS FROM VOLCANIC MATERIAL

One of the best and most frequent opportunities for illustrating soil formation from bare rock or rocky and stony materials through the agencies of vegetation, is furnished by volcanic eruptions which cover tracts of land and destroy all vestiges of vegetation. (No. 7) The eruption of Krakatoa in 1883 furnishes an example well remembered by this generation. Treub who investigated the lava fields came to the conclusion that the lava and pumice first became clothed with a thin film of simple one celled blue green algae and similar simple formations which prepared the way for the germination of abundant fern spores. Three years after this eruption, the new flora on this lava field consisted entirely of ferns, while plants with true seeds began to occur here and there along the water courses or on the mountains. Beccan found that the island of Sambava, which had been denuded of all vegetation and covered with lava by an eruption of the volcano Tamboro in 1815, was clothed from base to summit in 1874 with a virgin forest, all produced in the space of sixty (60) years.

LANDSLIDES

After the forests have been cut away from the hills and mountains of Pennsylvania and these have been burned over several times, land slides frequently lay bare acres of rock. Here the same constructive agencies begin operations, first, rock plants, lichens, algae, and mosses whose rootlets penetrate the rocks more or less deeply, depending on its hardness, porosity and its exposure to heat and cold and the presence or absence of water. The remains of these plants as time goes on, together with disintegrated rock and dust unless the decline is too steep, provide a scanty soil in which more highly organized plants can grow. Along the line of the old Tapeworm Railroad, in Adams county, Pennsylvania, are cuts made more than seventy (70) years ago through the Azoic rock from which there were land slides laying bare the rock upon which these lowly organisms have been at work during all these years, and they together with more highly organized plant life that came along later have formed a soil sufficiently fertile to produce shrubbery and trees six and more inches in diameter. On the fills of this railroad entirely composed of the rock blasted from the cuts through which it passes in this mountain trees even larger than those already referred to have grown and the crevices between the rocks and stones are well nigh filled with humus and disintegrated rock.

(No. 7). Warming, pages 350-352.

FOREST FIRES AND NEW SOIL FORMERS

Forest fires have been the most powerful agencies in changing the soil conditions of the hills and mountains of Pennsylvania, which at one time would, after the woodman's axe had cleared away the primeval forest, within a few years start a growth so luxuriant in many instances that the contention or struggle for existence between the species endeavoring to grow would not have been for fertility but for sunlight. These same soils after having been burned over again and again the organic matter burned off the surface, the seeds and living roots of the former shrubs and forest trees as well as the rhizomes and spores of highly developed allies or lowly organisms killed, here species of plants of an inferior character are now eking out a struggling existence. On the table land of the South Mountain, which at one time was covered with a dense forest of pine, all of which has been cut away and since then this land has been burned over again and again by the berry gatherers until today it is covered with a growth of scrub ground and Jerusalem oak, with here and there a scrubby pine of little value for firewood and less for any other use. And what is true of the South Mountain is true of many hills and mountains in Pennsylvania.

But besides the inferior growth already referred to, the soil has become covered with a dense mat of lichens, algae, and mosses of great variety which cover the sand to a depth of several inches, and which are not so readily effected by fire, and which, after the fire has inflicted its ravages, take advantage of that inherent co-operative quality of absorbing moisture from the air and soil and holding it for the inferior plant life that has taken up the work of soil rehabilitation in these mountains. While these lowly organisms hold considerable water and acquired fertility, they do not hold these as does a forest-clad hill or mountain with its roots and undergrowth and leaves, therefore, when heavy rains fall these mossy grounds become saturated with water and hills and mountains begin to wash down and the washing, roots up, well nigh all plants and the destruction of the hills and mountains has begun, and all on account of forest fires of which more are due to the carelessness of railroads than to all other sources of forest fires in this state combined. With the fire brand absolutely removed from these hills and mountains, it will require not sixty (60) years to re-construct forests and the undergrowth of our forests as it did in the eruption of Somboro, but within thirty years a new forest will be constructed and soil construction on our hills and mountains will again go on in this State as it did in the immeasurable ages of the past.

What is true of soil destruction by the fire brand and of soil construction by forest growth, is true of soil destruction by farming in which more organic matter is burned out than put into the soil,

and the methods of farming, by which a little more is added than is taken out. Upon such soils, with good farming better and better plant life will grow. Such soils will not be like so many soils in Pennsylvania are today after having been farmed many of them for more than a century and after having been sown with good seeds such as clovers, timothy, redtop, etc., for this length of time will when the soil is un-occupied by a crop, produce a horde of weeds instead these constructively farmed soils will produce crops useful for man and beast.

PLANT LIFE IN LOWLANDS—FRESH AND SALT WATER

The development of plant life along and in the water follows well nigh the same lines of development as do those upon rock and partially decomposed rock, except that in many instances it is very much faster. Water mosses and algae as well as other low water loving plants, such as eel grass and glasswort, grow along close to and sometimes in sea water. In fresh water besides the mosses and algae, plants are usually arranged in zones depending on the depth of the water and the kind of soil under water. In shallow, deep and running water the Characeae a family of plants allied to the algae, grow, while the thousand leaved or water Milfoil grow under water. The pond weed family and Spatterdock, and the White Crowfoot all find a congenial environment closer to the shore, while beyond these the reed family especially in warmer climates find a congenial soil. As seasons come and go the remains of these plants together with the accumulation of decomposed rock under the water as well as that brought by currents of water and wind build up until the bottom of the body of water is raised sufficiently for marsh plants to take the place of the pioneers already referred to among which the water parsnip, the rush family, the Horse tail, etc., are among the first. When the soil is raised sufficiently above the water, grasses begin to appear, later meadows, then willow and alder bushes and finally forests.

Successions of development vary with localities and climatic conditions and may be produced in many ways; for instance, bog mosses may do the pioneer work and upon these soils members of the heath family, to which the cranberry belongs, then the birch family of trees, then the pine family, then, depending on the locality if in the southern part of the State, the swamp Spanish or pin oak, later when the soil is dryer and more fertile, comes the swamp white oak, then the lowland black oak, and finally the white oak. All the causes that are responsible for the changes and improvements in vegetation on barren rock and in water during the past ages is difficult to decide; but that such improvements have taken place is undoubted. Climatic changes and conditions certainly played an

important part. But it is evident that with the increase of organic matter in the soil, more exacting species displaced the more accommodating and when humus decreased the more accommodating species appeared again. This has happened in many places in Pennsylvania soils which were at one time covered with hard wood forests or some of the exacting species of which they were cleared and farmed for years, then abandoned, are now endeavoring to grow spruce, hemlock and pine forests or scrub oak all belonging to the more accommodating species.

The same thing is taking place on the depleted cotton and tobacco soils in the Southern states where the scrub pine takes up the process of soil rehabilitation. This soil constructive operation by means of rock disintegration and humus accumulation has gone on in this State during immense ages and is still going on until a vast acreage of soils ranging from a few feet to more than twenty feet in depth ready for agricultural plants has been formed.

With this constructive process, the farmer with his methods has, in many instances, interfered, which nature, as soon as his destructive hand is withdrawn, again takes up. The farmer and farming methods must no longer be destructive, but like nature constructive. As already indicated, the process of disintegration is still going on and will for ages to come and will slowly make available, by means of solvent agencies, whatever plant food may be contained in the disintegrated rock and the agricultural plants will take up the made available mineral fertilizing elements, build these into plant tissue, and unless removed from the soil by man for his own use or to be wasted, will return all to the soil for the use of new generations of the plants, so that where the soils are sufficiently developed for growing agricultural plants, nature still continues her constructive operations, an undeniable evidence that man with right methods, which are in harmony with nature can also be constructive.

Here the assertion will be made that the farmer can not return all he produces on the soil back to it. He must use these products for his own and the maintenance of the lives depending on him as well as all the non-producers of farm products, and, therefore, can not return these to the soil, all of which is very true. Here then the question naturally arises, is it right for the farmer to continue a practice which, if followed indefinitely, will render useless the soil, the medium into which he sets his plants for entrapping the solar radiation and store it to furnish human nutrition, or shall he adopt a practice by which he can produce all crops necessary for human nutrition and return in sufficient quantity all by-products that the soil can work over into available plant food and in this way maintain its productive capacity indefinitely.

Here the higher than nature's function of the farmer appears that of so utilizing the by-nature's processes constructed soil for growing agricultural plants that these will yield the largest and most available food supply for human nutrition, and at the same time, retain and even enhance the productive capacity of the soil. This dual function of the farmer, of food producer or energy furnisher for all human activity and soil fertility maintainer and enhancer, makes him the agent by whose labors are furnished the nutriments which operate the bodily mechanism of all those who are employed in the agricultural, manufacturing, mining, transportation, commercial, educational, governmental, religious and all other systems in our intricate civilization, as well as the conservation of that medium upon which depend the existence and possibilities of all these and whatever systems future developments may add to them. With such responsibilities resting upon him, this farmer, of all men, should also be the most highly trained in his art, so that mankind, in a land flooded with an immensity of solar radiation and rain, it would be impossible for humanity to go hungry much less to starve.

CROPS CONTAINING HUMAN NUTRITION

Of all the foods produced by the farmers of this State, the cereal grains contain the largest quantities of the most easily made available carbohydrates, fats, proteins and mineral salts required to operate the human body, and among these, wheat is first. The State has a large acreage well adapted to its growth, and not only this, but a considerable acreage upon which a superior type of wheat can be grown. The question will naturally be asked, Can this crop be made to fulfill the dual function of the farmer, that of furnishing food for mankind and maintain the fertility of the soil? Nearly all of the wheat kernel beneath the skin, or that part which makes the bran, is available for human nutrition. A crop of 20 bushels of good clean wheat per acre or 1,200 pounds, a quantity raised in most of the wheat-growing sections of the State, contains about 28.50 lbs. nitrogen, 11 lbs. phosphoric acid and 8 lbs. potash, and will make between 800 and 900 lbs. or a little over 4 barrels of good flour, containing, according to analysis (Bulletin No. 15, Experiment station work U. S. Dept. Agri. table 2) about 18 lbs. nitrogen, 4.70 lbs. phosphoric acid and 4.40 lbs. potash. The straw, estimating 2,500 lbs. per acre, contains 24.75 lbs. nitrogen, 3 lbs. phosphoric acid and 12.75 lbs. potash, making a total from both wheat and straw of 53.00 lbs. nitrogen, 14.0 lbs. phosphoric acid and 20.0 lbs. potash.

If all these products would be sold and taken away from the farm, the soil would be deprived of the fertility they contain and the organic matter, which is so potent a substance in soil construction as well as other functions in maintaining its productiveness. Such an

operation would be out of harmony with the processes of nature and with the dual functions of the farmer. The flour represents only, approximately, 25 per cent. of the wheat crop, and is directly available for human food. Of the 75 per cent. not available for human food, about 10 per cent., the bran and middlings, are especially adapted for animal nutrition, and through the animal, a part of these by-products can be converted into human food, and the part not so converted returned to the soil in the excrement of the animal, which contains about 80 per cent. of the fertility in these feeds. If only that part of the wheat crop available for human nutrition is sold off the farm and the bran and middlings, are fed to animals on the farm, the straw used as absorbent for the animal excreta derived from these feeding stuffs, then well nigh all the fertility contained in the bran and middlings and all that contained in the straw amounting in both to about 25 lbs. nitrogen, 10 lbs. phosphoric acid and 16 lbs. potash per acre, together with the organic matter these contain, are returned to the soil, while only about 4 lbs. phosphoric acid and 4 lbs. potash, mineral elements of fertility contained in the flour, must, by future crops, be obtained by further and deeper rock disintegration, or be supplied by the application of commercial fertilizer and the nitrogen amounting to 17 lbs. per acre gotten from the air through leguminous crops. How long a soil would continue producing wheat in paying crops by returning to it the straw partly used as absorbent for the excreta of the animals fed with the bran and with the remainder of the straw as roughage and by supplying the fertility contained in the flour by the application of commercial fertilizer, I do not know, but I am willing that it should be compared with the method of selling all the straw and grain and applying commercial fertilizer to supply what has been sold.

The cereal crop furnishing the largest quantity of human food best adapted to the needs of the body next to wheat, is corn. A crop of 40 bushels of shelled corn per acre, the average yield in this State for the past few years, contains 44.0 lbs.* nitrogen, 17 lbs. phosphoric acid and 9.74 lbs. potash in the grain and the fodder estimated at 4,000 lbs. per acre contains 41.6 lbs. nitrogen, 11.6 lbs. phosphoric acid and 56 lbs. potash, making a total for the crop of 85.6 lbs. nitrogen, 28.6 lbs. phosphoric acid and 65.74 lbs. potash. From these data it is evident that on farms from which the crop of corn is sold and the fodder wasted in a most shameful way, as is the case in many sections of the State, that there is an enormous loss of fertility and that soils with such treatment must be exceedingly well supplied with the elements of fertility or they would cease to produce any crops. The reverse, however, is just as true as is well demonstrated in the cattle feeding sections of the State where all the corn and a large part of the fodder are fed to steers and where at least 80 per cent.

*Bulletin No. 15, U. S. Dept. Agri. Table 2.

of the fertility contained in the grain, a large part of the organic matter contained in the fodder, especially that part used as absorbent, are returned to the soil directly from the stable or pen. Here there is no such thing as worn out soils; but these soils become better and better, and the likelihood is that such a system of farming with careful management, specially if the corn fodder used as absorbent, would be shredded could be carried on indefinitely. But according to Dr. Armsby, only about 3 per cent. of the solar energy stored in a bushel of corn is recovered in the edible carcass of the steer to which it is fed. This method of using food 81.4 per cent. of which is digestible, a very large part available for human nutrition is entirely too wasteful and expensive and is a method of farming more for maintaining soil fertility than for human food, whereas, wheat farming is farming more for human nutrition than for soil fertility, therefore, will a combination of the two furnish a larger amount of human food and at the same time maintain the fertility of the soil. This naturally brings us to crop successions or the combinations of agricultural crops so as to get the largest quantity of human food and at the same time do constructive farming.

CROP ROTATION, LIME AND COMMERCIAL FERTILIZER IN CONSTRUCTIVE FARMING

Crop rotation or succession or having different crops follow each other on the farm was practiced in the Eastern states especially in Pennsylvania for more than two centuries. In the early stages of agricultural industries in the Atlantic Coast states, especially the so-called Middle Atlantic states, it was necessary for the farmer to produce all the food needed for himself and family, and his help on the farm as well, as that needed for feeding the animals on the farm, and therefore he raised wheat, rye, corn, buckwheat, potatoes, etc., for himself and family and corn, oats, barley, rye and hay for his animals. This early farmer, therefore, had a wheat field, a rye field, a corn field, a potato field and a hay field.

If tradition can be trusted and the primitive practice of the Southern farmer is an indication of what had been the practice in the more advanced states in agriculture, then this farmer raised these crops on the same field year after year. In the more advanced farming section this primitive practice was abandoned more than a century ago, because the farmer saw that wheat can follow oats as well as wheat can follow wheat or that a short season summer oat crop could be raised in well nigh all the Northern states and a long season winter wheat crop started as well as if the field had been sown with wheat and that the short season summer oat crop can follow corn as well as the short season summer corn crop can follow corn. And still farther, the farmer found that a sod field when well plowed

(after the iron plow had been invented) would produce a larger corn crop than a field upon which corn had been grown year after year, then why not plow up a sod field that no longer produces a paying hay crop. With the knowledge that larger crops can be raised with crop rotation and with the invention of soil culture implements, rotations became a panacea for all crop failures. This field produced a crop of corn and, therefore, it should be in good condition to produce a crop of oats the following Spring, was a general comment by the farmers of those days. These farmers contended that the soil was made more fertile by crop rotation and therefore in order to keep up the fertility of the soil and increase the crop yield the only thing necessary was to raise a different crop on the soil as frequently as possible. Why there should be a decrease in yield by the succession of the same crops on the same soil in even so short a time as two seasons is difficult to explain. Whether this condition in the soil is the result of toxic substances produced by the plant refuse, or whether it is the inability of the succeeding plant making the same demand on the soil to find sufficient plant food suited to its taste or whether that fertility has been contaminated by the proceeding plant so that even if it be present in abundance the plant will not utilize it or whether there is an inherent quality of the soil of being more kindly disposed to a succession of different plants than to a succession of the same plants, has not been determined.

This is not the place to discuss and theorize on this subject. As above stated short and long season crops were made to follow each other, such as oats and wheat, or two short season crops such as corn and oats which were raised in approximately the same time that was required for raising one long season crop of wheat. With the more indolent and indifferent farmer, crop rotation was an easy way to keep up the productiveness of the soil because, if a succession of crops will keep up the fertility, then he did not need to apply manure which consequently he did not do. He did not need to cultivate his soil especially and therefore the oat field was not well prepared for seeding wheat, neither the corn field for seeding oats, nor the sod field for planting with corn, because a different crop will thrive independently of all these; but the time came when crop rotation failed to bring the results its early adoption promised. Early in the nineteenth century a large acreage of the farming land of the Middle Atlantic states where, crop rotation had been developed to its utmost and had failed, was regarded no longer adapted to farming and was not farmed and those who owned it sold out and went farther west and began to do over again what they and their ancestors had done in the east, either by following crops of the same kind or having a rotation of different crops, ending with a repetition

in many instances of a reduction in yield to such a degree that further westward emigration was taken up by the more shiftless farmer who simply raised crops for the money that was in it regardless of the effects on the soil and when returns from the soil were no longer satisfactory, he was either ready to move again or to try other means of soil improvement.

The farmer who remained and tried other means of soil improvement is still trying these other means of soil improvement. The first of these was the use of well rotted manure. Manure not well rotted was regarded of very little value to the soil. With so perverted an idea of manure, one-half and many times two-thirds of the value of the manure was lost during the process of decay in the barnyard or wherever it was piled up unless protected by a covering of some sort. On account of the loss sustained by handling the manure in this way, a way that is still in vogue in many places, there was not a sufficient quantity of manure to keep up the organic matter farmed out of the soil by crop production, and so much of the fertility the manure contained was lost by leaching and decay outside of the soil that there was a continuous decrease along both lines which resulted in a lessening and lessening of crop production as time went on. Soil stimulants were tried, among them salt and lime, plaster on ground gypsum with, in many instances, gratifying results, but these were as ephermeral as crop rotation and the application of small and leached quantities of manure. Late in the eighteenth or early in the nineteenth century when crop rotation and the application of the small quantities of the leached and well rotted manure had failed and when crop failures were common and when a large number of the young men of the Middle Atlantic states and the Northeastern states were leaving the more eastern settlements and going farther westward and as already stated did again what had already been done, another method of soil improvement came into vogue, that of applying lime to the soil. Within a few years after the application of lime, crop yields were doubled wherever lime was applied and liming became universal in the grain and grass raising sections of the Eastern and Middle Atlantic states. Liming together with crop rotation, the application of well rotted manure and the plowing down of sods, a practice followed by the more advanced farmers, was destined to become a more effective agency of soil improvement than had up to this time been introduced by the farmer.

It must be remembered that caustic lime was the form of lime, used at this time. At first small quantities were applied, and when it was noticed that so small a quantity produced such wonderful results, the farmers concluded that with the increased application of lime, the crop yield would increase and therefore as much as three hundred bushels, or twelve tons of caustic lime was, in many

instances, applied to an acre, and if the soil happened to be sandy, shaly, loamy or, in many instances, a large number of clayey soils were made so caustic that they did not produce any of the agricultural crops for a year or more, then the evil effects of lime became evident; but they were not understood. But lime, like crop rotations, too, failed, then came commercial fertilizer containing the elements of fertility in which many soils seem to be deficient, and up to the present time has held the stage whether it will continue to do so, the future of agriculture will decide.

It is evident that crop rotation, liming and commercial fertilizer are not the panaceas that will cause the soil to produce crops for human food, the limiting factors in which are sunlight and rain, but that each one of them can be used in an effort in bringing about so ideal a condition cannot be denied. A crop rotation that will furnish the largest amount of food for human nutrition is one in which the cereal grain that can be successfully grown in Pennsylvania, such as wheat and corn, occupy the largest acreage, where the soils are sufficiently fertile and the season long enough which is the case in the southern but especially in the southeastern section of the State to raise clovers between the long season, and the short season corn crop, the following succession could be followed. Beginning with corn, which should be planted not later than the middle of May, and should be a variety that will ripen early in September when it is cut near to the ground and drawn together in large shock rows and the ground which if the corn has been cultivated as it should have been will be in good physical condition and will need only the preparation that a well cultivated, plowed after harvest, stubble field, will need to put it into condition for sowing with wheat about the latter part of September. After the wheat is harvested the following summer the soil is disked and sown with cowpeas. They will in a normal season, especially if Northern grown seed is sown, grow until the middle of September when, if they have made a sufficient growth, they can be made into hay and used as roughage and the ground again disked and sown with rye and hairy vetch or, if the growth is not large enough to make hay, they are plowed down, the soil put into good cultural condition and sown with rye and hairy vetch and these if possible made into hay the following spring or plowed down and the ground planted with corn.

In a rotation like this there would all the time be a growing crop on the soil to take up whatever fertility might become available and to entrap and store up the energy of the sun, and in the case of the clovers, procure nitrogen from the air and build all these into plant tissue to be used as food for animals and all straws and bi-products converted into fertility, and these in turn furnish food for man. No

pasturing of animals is possible in a rotation like this (except the Cow Peas might be pastured for a few weeks by hogs) and, therefore, some of the corn should be siloed and the animals fed with silage, and whenever possible the rye and hairy vetch should be made into hay for the animals as well as the Cow Peas. The only products sold off this farm are the flour and the animal products, whether beef, pork, or milk derived from feeding the bran and middlings, corn silage, corn fodder, cowpeas, rye and hairy vetch hay, and the straw and the corn fodder and manure of the animal returned to the soil to keep on building as nature did. If the main desire was to get all the available human food out of these two crops all the corn except that needed to feed the animals could be sold and the roughage together with the manure and some commercial fertilizer returned to the soil. A rotation like this is not suggested for any section of the State except for the less elevated southern sections, especially the southeastern, where grain raising and in many places hog and cattle fatting has been made an industry.

Another succession of crops in which the cereals occupy the largest acreage and one that will furnish a large amount of human nutrition and organic matter to return to the soil and is adapted to well nigh all sections of this State, is made up of corn, grass and wheat.

Beginning again with corn which, in this case, may be a variety that will take up the entire season at any locality in the State to ripen the crop, because the crop of grass which is to follow corn will be sown with the corn about the beginning of August and no crop will be sown after the corn is cut.

The grass or clover crop may be all clovers composed of equal quantities of red and alsike or some alfalfa may be added for part, the alsike or it may be all red clover or where the crops have been successfully grown, it may all be alfalfa or a mixture of red alsike alfalfa and timothy sown, sometime early in August in the southern section of the State and probably better, the latter part of July in the northern section. Level cultivation must be practiced and the corn must be cut at the ground so that there shall be no corn stubble. In a good well cultivated soil with good clean seed sown with an inter row seeder, this will produce a crop of hay the following June. A second crop will grow, especially if the clovers have been sown or can be pastured for some time and then plowed down and the ground put into condition for wheat. Sometime in April of the following spring the wheat field is sown with clover and timothy and is cultivated with a weeder and the seed covered with the weeder. This will make a crop of clover for a fall hay crop if the soil is strong or for clover seed and for plowing down the sod the following spring to be planted with corn. In this rotation the long

season hay crop is sown with the short season corn crop and the long season wheat and clover crops are made to overlap the same as the hay and corn crops and in this way there is always a clover sod to plow down for wheat and for corn. The flour of the wheat is one of the money crops and is sold, the bran and middlings are fed, the straw is used as absorbent and therefore only the fertility contained in the flour of this crop is not turned back to the soil.

In rotation like this, some of the corn should be siloed and some of the grain in connection with some cotton seed meal fed to animals and some might be sold in the grain without injury, especially if cotton seed meal is used.

Here we have a two years, three years and the old four or five years succession or rotation of grass, corn, oats, wheat and some times wheat a second time, and then grass a rotation is very largely followed by well nigh all grain farmers in the State, but is not calculated as now practiced to either furnish the largest amount of food for human nutrition and at the same time maintain the fertility of the soil because usually there is only one clover crop in four years and the whole wheat is sold and sometimes a large quantity of corn and hay and even straw and the grass or sod fields pastured down to the roots and the soil compacted that it cannot breathe and the very life is pressed out of it.

The old rotation is a good one and the reason that it does not perform the dual functions of the farmer is because it is abused. As we have already seen, it is the interlocking of long and short season crops in the two and three years successions to produce the clovers and the organic matter and by selling only the manufactured human nutrition in the shape of flour and animal products and by turning all animal excreta and roughage back to the soil that it is possible to maintain its fertility. This same thing can be done even more effectively in the four or five years rotation. Corn is a short season crop and so is oats. These two crops usually follow each other. If it is not possible to raise one of the short season clovers, such as crimson or the winter hairy vetch with some rye to sustain it and to furnish organic matter in which the soils that have been farmed in the manner already stated are deficient, sow a mixture of three quarts crimson clover seed, three quarts hairy or winter vetch, one-half pound cow horn turnip or any other beet seed that may be desirable and a half a bushel rye to the acre with an inter row seeder. Some of these will grow and furnish some organic material to construct soils. Plow down this crop the following spring and sow oats and with it four quarts Mammoth or red clover seed, or better still oats and Canada field peas a clover with one of the grasses. In the southern section especially the less elevated if the season should be late soja beans, a clover can be sown instead of oats. These will

ripen and will be out of the way in time to prepare the soil for wheat. Some places one wheat crop follows the oats, other places two and with these timothy and clover are sown the former usually in the fall of the year and the latter some time in the spring. In the northern section of the State the wheat is cut out of this rotation and the clovers and grasses are sown with the oats.

This old four or five or some times six years rotation can be made more constructive than either the two or three years succession because with the corn a short season crop, a short season clover can be raised with and after it, and the oats and Canada field peas both a short season grass and clover and Mammoth or red clover with the wheat the first year, if wheat is to be followed with wheat the second year and timothy and clover for hay the last year. Plow down the crimson clover, hairy vetch and rye unless conditions are such that a crop of hay can be made of these, than make hay, feed this to animals and convert it into edible human nutrition, sow the field with oats and Canada field peas or oats and Mammoth or red clover, or if the season is late, with soja beans. Make hay of the Canada field peas and oats if these were sown or if oats, leave it ripen, harvest and allow the clover to grow until time for plowing for wheat which may be late in August or early September. Do not pasture—for this is always bad and injurious to the soil. If soja beans have been sown, make these into hay or leave them ripen and thresh and use the seed for feed for animals after grinding, and prepare the soil for wheat and sow as already indicated.

The usual manner of disposing of the crops and roughage from this old four, five or six years rotation is to sell the whole wheat, a large part of the corn, some of the oats, hay and straw, raise only one clover in the four, five or six years, pasture this down several times to the roots, pile up the straw and the unshredded corn fodder together with the excrement of the animals for which these were used as absorbents while the animals were housed, or while in the barnyard apply this barnyard manure once or twice a year to the soil and then atone for this kind of soil treatment by applying some commercial fertilizer. This practice is not excusable in this State, but bad as it is, it is better than two-thirds of the agriculture practice in this country.

In order to furnish a legitimate amount of human nutrition from this operation and continue soil construction, sell the flour from the wheat, feed the bran and middlings, sell some of the corn, feed the remainder, feed the oats, or the Canada field peas and oats or the soja beans, silo some of the corn, feed this, shred the remainder of the corn fodder, feed it together with the clover hay, sell the animal products derived from these feeds, use the straw as absorbents for the animal excrement, apply the stable manure as made, to the grass

field whenever possible until it is covered, than to any growing crop that may be convenient and with such fertilizer or lime as the crops may indicate, this soil will retain its original producing capacity and increase it. In the case of the rotation in the northern section of the State from which wheat is eliminated the corn and oat crops are the only cereals salable and in many instances oats the only one. Climatic and soil conditions are especially favorable here for the raising of oats and, therefore, it should be made a crop of commerce from this section and the rotation so arranged that this could be done. A succession of crops already indicated is grass after grass, corn, then oats and then back to grass. An improvement on this would be a clover, such as the hairy vetch sown with the corn, sometime in August, sown with an inter row seeder. A half pound of cow horn turnip would not hurt to be sown with the vetch. These plowed down the following spring and the ground sown with oats and Canada field peas and then to grass. The land sometimes remains in grass for three or four years, so that frequently two-thirds of the farm is in grass. When this is the case and it is at all possible, alfalfa should be made the hay crop and should be sown with the oats. With alfalfa, corn and corn silage fed to animals, the manure used as already indicated all the oats could be sold and still the soil's productiveness maintained especially if some concentrated feeding stuff, such as cotton seed meal and suitable commercial fertilizer would be used in sufficient quantity to supply the fertility sold with the oats, and the animal products derived from these feeds which are also converted into money.

Many of the farms have large acreages in permanent pasture which in many instances has badly run out and should be made to produce more, both for human nutrition and for keeping up the productiveness of the soil. Probably one of the quickest and best methods of bringing these soils back to their original productiveness can be accomplished by plowing up the old sod as early in the spring as possible. Disk harrow a number of times, and put into the best cultivated condition, and if advisable, plant with corn and raise a crop of corn; but it seems a better plan would be to sow with buckwheat, and four or five quarts crimson clover or a half bushel of winter vetch to the acre. After the buckwheat is harvested, allow the crimson clover or vetch to grow until the ground must be gotten ready for sowing rye and hairy vetch. The rye and hairy vetch can be made into hay the following spring and fed to animals and the manure applied to the soil or to get into more definite harmony with the purpose advocated, that of producing human nutrition and fertility, the rye and vetch can be plowed down and the ground prepared for corn and the corn either siloed or allowed to ripen and in either case fed to animals. After the corn is cut and the ground prepared,

it can be sown again with rye and hairy vetch, but what is still better, clovers and timothy or alfalfa can be sown with the corn, sometime late in July or the beginning of August and in this way without any more cultivation than the corn should have, the soil is brought back into grass. Here is a crop of buckwheat for food for men and animals, a crop of crimson clover to plow down, a crop of rye and hairy vetch for hay and the stubble to plow down or depending on conditions, the whole crop to plow down, a crop of corn to be converted into human nutrition and the remainder returned to the soil and the ground back into grass. This may take only two years or it may take four or six years, but whatever time it may take, an operation like this or another that will accomplish the same purpose that of producing crops for human nutrition or rehabilitating the soil is worth the while and should be done. A soil handled in this way will stop growing weeds and instead will grow agricultural crops.

HUMAN NUTRITION FROM ANIMAL PRODUCTS

In many sections of the State milk and butter dairying are the chief agricultural industries, because the farmers get larger financial returns from these than they do from raising the larger amounts of human nutrition in the cereal grains, therefore, a succession of crops should be arranged to furnish food for the dairy herd, containing the ingredients to give satisfactory returns and at the same time build up the soil without the purchase of large quantities of concentrated feeding stuffs.

The cereal containing the largest quantity of available animal nutrition raised in Pennsylvania is corn, but it does not contain a sufficient quantity of the proteins to give the best results in animal products. Therefore, the question arises, Can this deficiency in this cereal be supplied or other feeds produced on the farm and financial returns obtained equal to those gotten from the feeding of concentrated feeds and at the same time maintain the fertility of the soil. This can be done in several ways either by raising a high protein containing a legume, such as the Canada field pea in the northern section of the State and some of the varieties of the soja beans in the southern section or by raising and feeding a high protein containing roughage. The latter seems the more feasible, because the Canada field pea frequently does not produce a large quantity of seed and the soja beans, sometimes acts in a similar way and when it does produce seed it shells out so easily that a large part is lost. The animal should not be overfed with roughage and underfed with grain, but the roughage ration and the grain ration should be arranged to accommodate the capacity of the animal, and to do this, certain quantities of the concentrates may have to be supplied for

some individual animals. It will, therefore, not be necessary to supply a larger quantity of the superior roughage than what might be termed the inferior.

Roughage crops, especially silage, are heavy and bulky and, therefore, difficult to handle and for this reason, the barns where the animals are kept should be located at such a place on the farm, so that the fields would be as close as possible to it, so as to make hauling distances as short as possible while at the same time have the barn as accessible as possible otherwise.

Silage is a heavy crop and difficult to handle and should, therefore, be raised right by the silo. As already indicated, roughage could more likely be the high protein food in this operation and, therefore, silage, the main one of these feed should be high in protein and for this reason at least half of it must be a clover. The land upon which the silage is to be raised should be right by the silo and should contain a sufficient acreage to be divided into two sections for a two year's rotation, one to be planted with corn, the other with soja beans, a clover or any other suitable legume the first year, the next season reverse the order and so on. A short season clover must be sown after the soja beans and with or after the corn to take up whatever fertility may be made available and to catch the energy of the sun that falls on these fields during the fall and spring of the year, either to be made into hay or plowed down when these fields are again prepared for corn and soja beans, or other legume.

The remainder of the farm, which would likely be about three-fourths of it, can be divided to raise crops, such as may be required to feed the animals. If dairying is the main operation, divide the remainder of the farm into two sections, raise corn on the one and clover either red and alsike or alfalfa on the other if this crop does well, all of them sown with the corn with an inter row seeder, sometime late in July or early in August. Other successions can be arranged for raising the crops needed. The silage and clover hay will furnish about all the roughage needed by the dairy and, therefore, a large part of the corn fodder after being shredded is used as absorbent for the excrement of the animals and applied directly from the stable on the clover and corn fields during the whole year. In an operation like this, animal products or animals are the only salable crops, everything else is returned to the soil and cannot do otherwise but increase its fertility. A still more simple succession of crop of corn and alfalfa may be practiced where only animal products are sold for human nutrition and where raising food for feeding these animals and maintaining the productiveness of the soil are essentials and where pasturing animals, especially hogs, may be desirable on account of not having all the labor that may be needed for attending to the feeding of all the animals and where they must, therefore be pastured.

The farm is divided into two fields, one for corn, the other for alfalfa. In this case the alfalfa must be sown with the corn some time late in July or early in August and the soil must be in the very best condition. In the southern, especially in the southeastern section of the State, the alfalfa can some seasons be sown after the corn is cut, but the soil must be fertile and in the best condition so that it will make a sufficient growth to winter well. The alfalfa should be allowed to occupy the soil for at least two years in succession and three years may be preferable and during these seasons a short season clover is sown with the corn every year and all the manure made on the farm during the fall, winter and early spring of these years applied to the corn land, which after the second or third year is sown with alfalfa as already indicated and the alfalfa field plowed up for corn and treated as previously described. This rotation is especially adapted for hog raising, because the hogs can be pastured on the alfalfa without injuring it and enough hay can be made afterward for all other stock, that can be kept on the farm beside the hogs as well as for the hogs. The corn is fed to the hogs to finish them, the corn fodder shredded some fed and the remainder used as absorbent for animal excrement and applied with the excrement on the field to be planted with corn. A little change in this rotation might be desirable and instead of growing corn on the whole half of the farm, part might be used for oats and barley for the hogs, but this will not change the general plan and principle. In this operation, all the manure goes back to the crops as it is made on the alfalfa, when the hogs are pasturing it and on the corn land directly from the stables and so do the grain feeds except what is used up by the animals in their body growth. It can readily be seen that this is a fertility raising rotation.

THE POTATO

The farmer is obliged to raise a number of crops demanded by the people, little of which can be returned to the soil, among these the potato is likely first in quantity. Usually these crops contain a low percentage of dry matter, as the potato, of which one thousand pounds or sixteen and *sixty-six hundredth bushels, contain 207.5 pounds or 20.75 per cent. dry matter. This amount of dry matter contains 3.10 pounds nitrogen, 1.3 pounds phosphoric acid and 4.8 pounds potash, therefore, a crop of two hundred bushel per acre or twelve thousand pounds would contain 37.2 pounds nitrogen, 15.6 pounds phosphoric acid and 57.6 pounds potash, and small amounts of other minerals such as lime and magnesia.

A succession of crops should certainly be arranged to supply the nitrogen for the potatoes and if possible bring potash within their reach, when minerals are disintegrating containing this element of

*Bulletin 15, Abid.

fertility as is the case with Chloritic and Micaceous shist rock of the southeastern section of the State, most of which are adapted to potato growing. A rotation followed in some of the potato growing sections of the State is clover, after clover, potatoes and after potatoes wheat and then back to clover. This is a good rotation for the richer soils, but in the poorer soils it must be depleting unless large amounts of expensive fertilizer are applied. For this reason, it seems a rotation of clover than potatoes, followed by rye, and hairy vetch to which manure is applied, the vetch made into hay and fed to animals or plowed down and the land planted with corn and a short season clover crop sown with the corn and this plowed down and the ground planted with potatoes or one or several of the long season clovers can be sown with the corn as already described, a crop of hay raised and the clover sod plowed down for potatoes. In this case, the corn, clover, hay and corn fodder would be fed to animals, the manure largely used on the corn ground, so as to have no baneful effects on the potato crop. This rotation would furnish organic matter and nitrogen and only potash with a small amount of phosporic acid would likely have to be applied to keep up the productiveness of the soil.

CLIMATE OF PENNSYLVANIA AND ITS EFFECTS ON THE AGRICULTURE AND HORTICULTURE OF THE STATE

Fertility or the available plant food in the soil depends on the composition of the rock from which the soil is derived and results from the processes of disintegration together with such chemical changes in the composition of the mineral constituents as well as such processes of fermentation and decay of the organic matter as will make these soluble in water and upon the various processes by which toxic substances are rendered harmless or neutralized. The ideal amount of available plant food and water, free from all toxic substances or agencies would be such as would supply the growing plant with all the moisture and mineral matter it would need to store up all the available energy of the sun under the prevailing climatic conditions.

These climatic conditions vary in Pennsylvania as they do in all places with distances north of the equator with altitude or elevation above sea level, with distances from large bodies of water, with changes in temperature, with the amount of rainfall and the number of days during which the sun shines while the soil climate is influenced in connection with the conditions above enumerated, by the natural or artificial drainage, its friable condition and

the quantity of organic matter the soil contains as well as in its location whether on hillsides facing east and south or north and west or in valleys.

LATITUDE OF PENNSYLVANIA

Pennsylvania has for its northern boundary the 42nd parallel of north latitude while its southern boundary lies a condsiderable distance south of the 40th parallel. The State extends an average of 302 miles westward from the Delaware River, its eastern boundary, and 175 miles north of Mason and Dixon's Line.

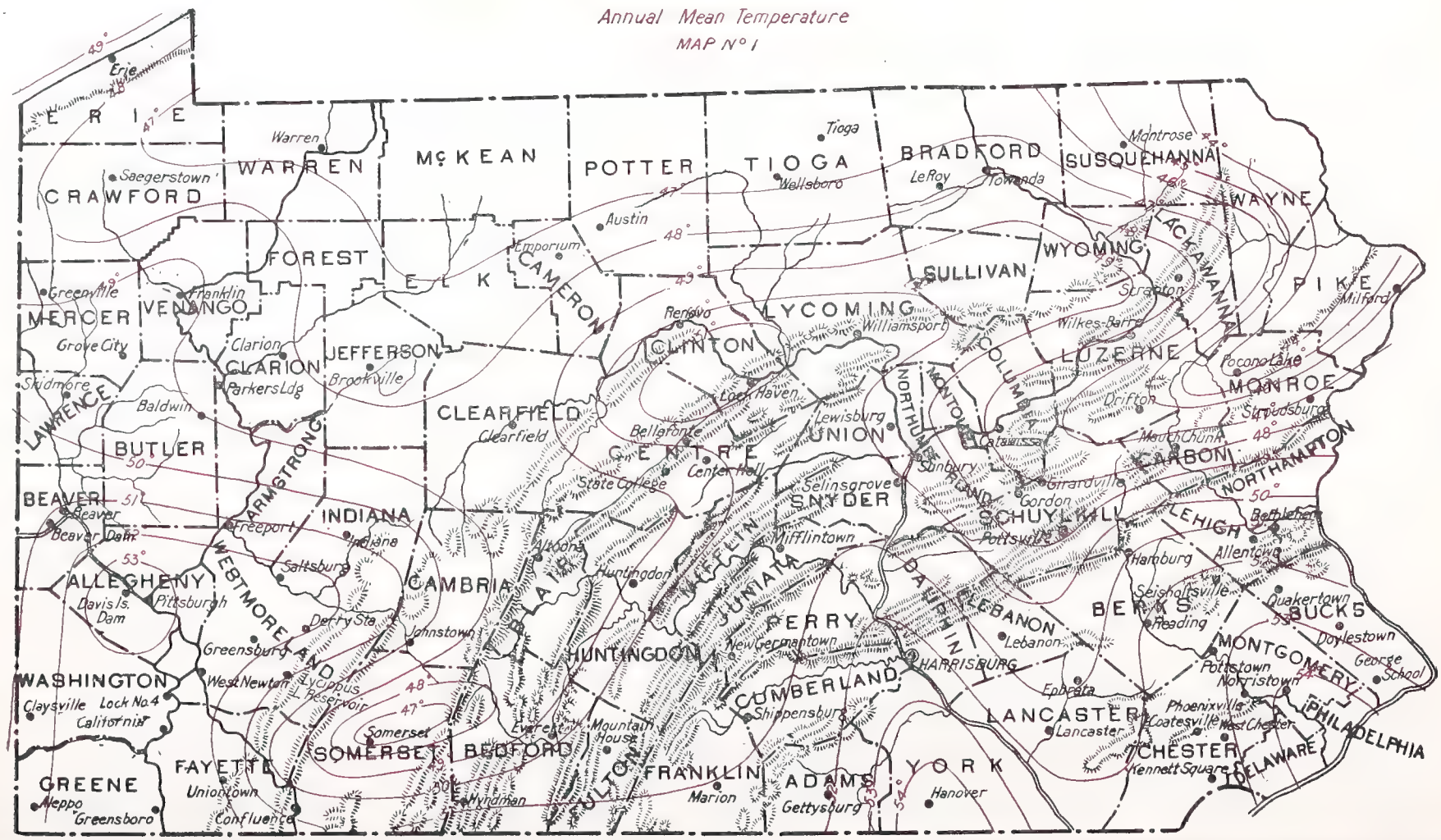
ANNUAL MEAN TEMPERATURE

The mean annual terperature of the State varies between 44 degrees in a limited area in Wayne, Pike, Monroe and Susquehanna counties in the northeastern corner, and 54 degrees in limited areas in York, Montgomery and Delaware counties in the southeastern part, a difference in the mean annual temperature of 10 degrees in a distance of 175 miles, but a variation in elevation in Wayne county between 714 feet at Narrowsburg, on the Delaware River, and 2,040 feet in Mt. Pleasant township and 890 feet, at Foster, Lenox township and 2,023 at Ararat township, in Susquehanna county. In the areas throughout which the mean annual temperature or the lines of equal temperatures on Chart No. 1 rises to 54 degrees the altitude is less than 400 feet above tide while the area in which the mean annual temperature is 53 degrees though not so limited follows closely the areas of 54 degrees except a limited one in Allegheny and Washington counties, where the altitude is normally less than 500 feet.

The area of 52 degrees follows that of 53 degrees, but similar to the two previous areas, passes out of the State into Maryland and West Virginia and not until the area of a mean annual temperature of 51 degrees is reached, beginning in the northeastern corner of Lehigh county with an altitude of 235 feet and 75 miles from the southern border of the State and extending to Hamburg in Berks county at an elevation of 392 feet, where it curves southward along the Blue Mountain, thence south to Ephrata in Lancaster county, then northwestward to the northern part of Dauphin county at an elevation of 418 feet along the river, thence southwestward along the Blue Mountain which it ascends to an elevation of more than 1,000 feet near the southern border of Franklin and Fulton counties, continuing in a westerly by southwesterly course until it touches Mason and Dixon's line along the highlands of Bedford and Somerset counties, reaching an elevation of 2,200 feet. After crossing Laurel Hill into Fayette county, it again changes northward along its western slope as far north as Blairsville, in Indiana county, at an elevation of 1,010 feet, thence westward to Freeport, in Armstrong county at an altitude of 770 feet and to Beaver, in Beaver county at an altitude of 710 feet from where it changes its western

Annual Mean Temperature

MAP N° 1



to a southern course until it reaches the southwestern corner of Greene county and passes out of the State, illustrating in a remarkable manner, the effects of altitude, and to a certain extent, that of latitude on the mean annual temperature of these various sections of the State.

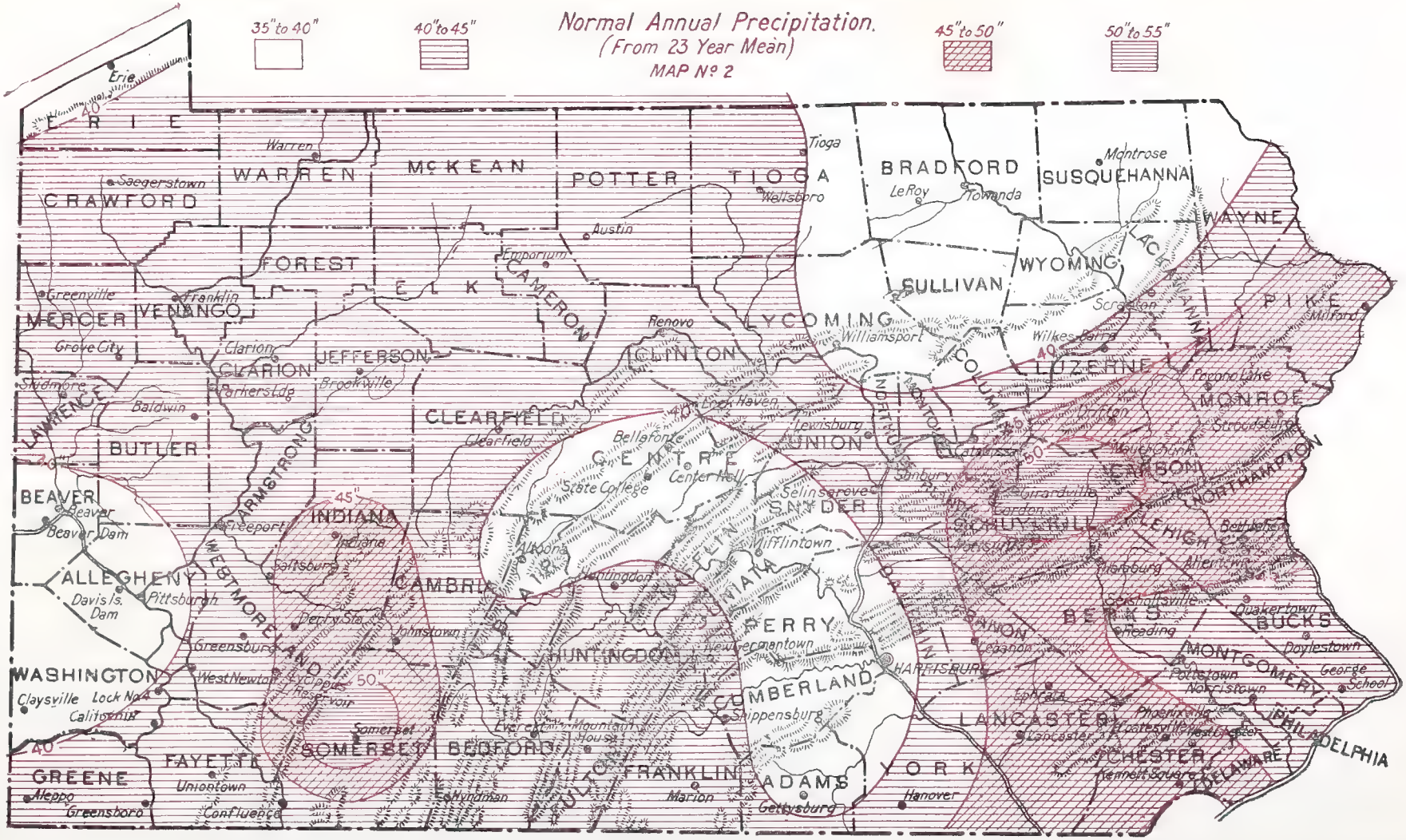
As above indicated, the effects of altitude are remarkably illustrated in this State. Montgomery, Delaware and York counties, with an altitude of less than 400 feet, approximately in the same latitude as Somerset, the former places having a mean annual temperature of 54 degrees while the latter, with an elevation of 2,200 to 2,300 feet, has a mean annual temperature of 47 degrees, a difference of 7 degrees or one degree for about every 300 feet, putting this section into the same agricultural zone as Bradford, Tioga, Potter, McKean, Warren, parts of Crawford and Erie counties, 175 miles further north.

The 49th and 50th degree isotherm or equal temperatures lines, illustrate still further these same effects and embrace the most extensive area of any in the State. They begin in the northeastern and central parts of Northampton county, at an altitude of 600 to 700 feet, crosses the Blue Mountain into Carbon and Schuylkill counties, then northwestward through Northumberland and the central part of Montour, at an altitude of 489 feet, then northeastward through northern Columbia and Luzerne to the southeastern corner of Wyoming county, at an altitude of 587 feet, thence northwestward to the northwestern part of Wyoming, thence westward through southern Sullivan and Lycoming at an altitude of from 530 to 760 feet, thence southward and eastward into Clinton at an altitude of 560 feet at Lock Haven, then southward and eastward to Mifflin county at an altitude of 525 feet, then southwestward through Huntingdon, west of Everett in Bedford county, from where they change southwestward, cross the mountain into and to the western border of Somerset county, south of Somerset at an altitude of 1,800 feet within fifteen miles of Mason and Dixon's line, from where they change their course northeastward into the central part of Cambria county, thence northwestward through southwestern Clearfield, northern and central Indiana and Armstrong into Butler county where the 49th degree isotherm changes northward to some distance north of Franklin in Venango county, and thence westward through central Mercer into the State of Ohio, while the 50 degree extends westward through Lawrence county into Ohio. The influence of latitude on the mean annual temperature is no where strikingly illustrated in Pennsylvania; but its effects are shown along the Susquehanna River, at an altitude of less than four hundred feet at York where the mean annual temperature is 54 degrees and in central Clinton county, 175 miles further north, where the mean annual temperature

is 51 degrees, at an elevation of 500 feet. Allowing for one degree of lower temperature for elevation, there is an approximate difference of two degrees, which is accounted for by latitude showing that a few hundred feet in elevation will frequently produce as great a change in temperature as several hundred miles of latitude.

INFLUENCE OF LARGE BODIES OF WATER ON TEMPERATURE

Not only does the same mean annual temperature as previously given extend close to the northern border of the State and approximately to the southern in Somerset county, illustrating how altitude mitigates the effects of latitude, but it also happens to be the prevailing mean annual temperature along the shores of Lake Erie more than one hundred miles further north than the northern limits of Lehigh county at an elevation of 573 feet, and the northern limits of the area reached in Sullivan county at an altitude of 530 to 700 feet above tide and that reached in Mercer county, at an altitude of 900 feet, demonstrating the effects of large bodies of water on the temperature of a county. Certainly the somewhat lower altitude of Lake Erie accounts for the lower mean annual temperature, but at least two degrees are due to the effects of the water in Lake Erie. The moderating influence of large bodies of water on the climatic conditions of the country bordering it, especially along the ocean making the climate warmer in winter and cooler in summer is due to two causes: That of its large heat absorbing and heat holding capacity and to the fact that fully half the heat falling upon the surface of water is used up in changing a certain quantity of the liquid into a vapor and consequently the heat so used is held in a latend condition and the temperature of the air on the surface of and surrounding the body of water is reduced until the vaporized water is again changed into a liquid or solid and fall as rain or snow when the latent heat again becomes appreciable. The heat not used up in the vaporization of water penetrates the water and raises its temperature to a depth of thirty feet during a single day while during the entire summer season the temperature of water is raised to a depth of 500 feet whereas that of the soil is not effected to a depth of fifty feet. Because of this larger storing of heat in water than in the soil and the tendency of the soil to cool more readily or giving up heat more easily than water the temperature of the soil and air in a short time equalizes while the temperature of water which is so much larger requires a longer time and therefore continues for a longer time to give up heat, all of which is manifest by even so small a body of water as Lake Erie and, therefore, instead of the mean annual temperature being what it would normally be at this latitude and altitude, is about two degrees higher.


Normal Annual Precipitation.
(From 23 Year Mean)
MAP Nº 2
35"to 40"
40"to 45"
45"to 50"
50"to 55"
ERIE
CRAWFORD
WARREN
McKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
PIKE
MERCER
VENANGO
FOREST
ELK
CAMERON
SULLIVAN
WYOMING
LACKAWANNA
LUZERNE
LYCOMING
CLINTON
COLUMBIA
MONROE
CLARION
JEFFERSON
CLEARFIELD
CENTRE
UNION
SNYDER
NORTHUMBERLAND
SCHUYLKILL
CARBON
LEHIGH
NORTHAMPTON
BUTLER
ARMSTRONG
LAWRENCE
BEAVER
INDIANA
WESTMORELAND
ALLEGHENY
CAMBRIA
BLAIR
HUNTINGDON
JUNIATA
PERRY
DAUPHIN
BERKS
BUCKS
MONTGOMERY
PHILADELPHIA
DELAWARE
WASHINGTON
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
CUMBERLAND
ADAMS
YORK
LANCASTER
CHESTER
GREENE
Erie
Warren
Tioga
Montrose
Waterford
Wellsboro
LeRoy
Towanda
Austin
Emporium
Renovo
Williamsport
Wilkes-Barre
Scranton
Honesdale
Milford
Pocono Lake
Stroudsburg
Bethlehem
Allentown
Easton
Quakertown
Doylestown
Norristown
Phoenixville
Coatesville
West Chester
Kennett Square
Wilmington
Philadelphia
Harrisburg
Lebanon
Reading
Pottsville
Shenandoah
Mahanoy City
Shamokin
Sunbury
Lewisburg
Milton
Selinsgrove
Mifflintown
Bellefonte
State College
Center Hall
Lock Haven
Clearfield
Curwensville
Grampian
Brookville
Punxsutawney
Clarion
Strattanville
Franklin
Grove City
Greenville
Mercer
Sharpsville
Sharon
New Castle
Beaver
Beaver Falls
Ambridge
Aliquippa
Pittsburgh
Davis Is. Dam
Sewickley
Greensburg
Derry Sta.
Johnstown
Indiana
Kittanning
Saltsburg
Creekport
Baldwin
Butler
Zelienople
Evans City
Slippery Rock
Portersville
Claysville
Lock No 4
California
West Newton
Cyclone
Reservoir
Somerset
Everett
Mount Aetna
Hopewell
Huntingdon
Mapleton
Shippensburg
Newville
Carlisle
Mechanicsburg
Camp Hill
Enola
Marysville
Duncannon
Newport
Mifflin
Lewistown
Port Royal
Thompsontown
Mexico
Millerstown
Liverpool
Perry Co.
Blain
Loysville
Bloomfield
Newport
Duncannon
Dauphin
Halifax
Millersburg
Elizabethville
Lykens
Williamstown
Tremont
Pine Grove
Schuylkill Haven
Orwigsburg
Auburn
Cressona
Port Clinton
Hamburg
Kutztown
Fleetwood
Boyertown
Pottstown
Norristown
Ambler
Abington
Jenkintown
Germantown
Chestnut Hill
Manayunk
Frankford
Bridesburg
Kensington
Camden
Gloucester
Chester
Media
Darby
Upper Darby
Lansdowne
Yeadon
Haverford
Bryn Mawr
Ardmore
Wayne
Radnor
Villanova
Conshohocken
Ivyland
Doylestown
Quakertown
Perkasie
Sellersville
Telford
Souderton
Harleysville
Lansdale
North Wales
Fort Washington
Jenkintown
Glenside
Hatboro
Willow Grove
Horsham
Warminster
Newtown
Langhorne
Yardley
Morrisville
Bristol
Tullytown
Levittown
Trenton
Princeton
New Hope
Lambertville
Frenchtown
Milford
Dingmans Ferry
Matamoras
Port Jervis
Delaware Water Gap
Stroudsburg
East Stroudsburg
Mount Pocono
Tannersville
Cresco
Pocono Lake
Lake Wallenpaupack
Hawley
Honesdale
Waymart
Forest City
Carbondale
Scranton
Dunmore
Olyphant
Jessup
Archbald
Old Forge
Moosic
Pittston
Wyoming
Kingston
Wilkes-Barre
Plymouth
Nanticoke
Hanover
Glen Lyon
Shickshinny
Berwick
Bloomsburg
Catawissa
Danville
Riverside
Northumberland
Watsontown
Milton
Lewisburg
Mifflinburg
Selinsgrove
Middleburg
Beavertown
Sunbury
Shamokin Dam
Port Trevorton
Penns Creek
Kreamer
Middleburg
Freeburg
Paxtonville
Troxelville
Adamsburg
Laurelton
Mount Pleasant Mills
Selinsgrove
Shamokin
Coal Township
Mount Carmel
Elysburg
Ranshaw
Watsontown
Turbotville
Muncy
Montgomery
Williamsport
Jersey Shore
Avis
Lock Haven
Flemington
Renovo
Emporium
Driftwood
Sinnamahoning
Austin
Costello
Port Allegany
Coudersport
Ulysses
Galeton
Westfield
Knoxville
Tioga
Mansfield
Wellsboro
Blossburg
Arnot
Antrim
Gaines
Ansonia
Liberty
Mansfield
Troy
Canton
Towanda
Monroeton
Sayre
Athens
Waverly
Sayre
Ulster
Towanda
Wyalusing
Rummerfield
Meshoppen
Tunkhannock
Factoryville
Clarks Summit
Dalton
Moscow
Jermyn
Archbald
Olyphant
Dunmore
Scranton
Carbondale
Honesdale
Hawley
Lake Wallenpaupack
Greentown
Bethany
Waymart
Prompton
Starrucca
Susquehanna
Great Bend
Hallstead
Montrose
Harford
Kingsley
Uniondale
Forest City
Simpson
Lenoxville
Thompson
Jackson
Factoryville
Tunkhannock
Nicholson
Meshoppen
Wyalusing
Rummerfield
Towanda
Monroeton
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Laurelton
Mount Pleasant Mills
Shamokin
Coal Township
Mount Carmel
Elysburg
Ranshaw
Berwick
Nescopeck
Shickshinny
Glen Lyon
Hanover
Nanticoke
Plymouth
Wyoming
Kingston
Wilkes-Barre
Pittston
Moosic
Old Forge
Archbald
Jessup

PRECIPITATION

As previously stated, fully one-half of the heat falling on a surface of water was used in changing the liquid into a vapor. This vaporized or gaseous water exists in the air or is suspended in the air and the warmer the air the greater its capacity for holding water vapor so that air at 60 degrees has three times as great water vapor holding capacity as air at 0 while air at 100 degrees has fifteen times as great a water holding capacity as air at 0°. The amount of water vapor that can exist at any time in the air depends on its temperature and therefore all the factors previously referred to such as latitude, altitude and the presence of large bodies of water which lower and raise the temperature of the air have a marked effect on the precipitation or rain and snow fall of any county.

ALTITUDE AND PRECIPITATION

The effects of altitude on precipitation are well illustrated in Pennsylvania. Somerset county, lying on the western slope of the Allegheny Mountain, contains the highest land in the southern section of the State. The moisture laden warm wind coming from the southwest from whence most of the cyclonic storms which bring the rains throughout this region come, strike these highlands, are cooled down and give up their moisture in rain and snow which, according to Figure 2, giving the annual normal precipitation for the last twenty-three years amounts to from 50 to 55 inches in this section, while in all directions it becomes less. Northward along these highlands to the central part of Indiana county the annual precipitation keeps to from 45 to 50 inches. Directly northeast and east of these areas and largely east of the Allegheny Mountains in Blair, northeastern Huntingdon, Center, northeastern Mifflin and Juniata, the greater part of Perry, eastern Cumberland and nearly the whole of Adams and a small area of western York, after the cyclones coming from the southwest have passed over the highlands of Bedford, Fulton, southern Huntingdon, Mifflin and Juniata where the precipitation ranges from 40 to 45 inches when they reach the low altitude of the Cumberland Valley and the slopes of the South Mountain, but especially the plains of Adams county where, because of soil formation, the air is warmer and consequently holds more moisture, the precipitation is less and ranges only from 35 to 40 inches or from 5 to 20 inches less than on the high elevations previously enumerated.

Another area of precipitation ranging from 45 to 50 inches occurs in the eastern and southeastern part of the State covering the southeastern part of York, the greater part of Lancaster, nearly all of Chester and Delaware, extending northward over Lebanon, the greater part of Berks, all of Lehigh and Northampton, across the

Blue Mountain into Schuylkill county, where the precipitation rises to from 50 to 55 inches which is also partly due to the high elevations along the northern border of this county. At Long Pond in southeastern Sullivan county the altitude reaches 2,200 feet above tide but also to the recurve of the coastal storm from which the increased precipitation of this southeastern part of the State are derived which covers the whole area except Bucks, Montgomery, Philadelphia, northern Delaware, eastern Chester and Berks where the precipitation ranges from 40 to 45 inches, likely due to the decreased snows of the winter and the decreased rain fall of mid-summer caused by the great heat reflecting soils of Mesozoic derivation and because the elevation is less than two hundred feet in much of this area.

Northern Wayne, Northern Lackawanna, northern Luzerne, northern Columbia, Montour and Northumberland, central and eastern Lycoming, eastern Tioga, all of Bradford, Susquehanna, Wyoming, and Sullivan counties compose another area in which the precipitation ranges from 35 to 40 inches which is partly due to the mountain barriers running northeastward through Columbia, Luzerne, Lackawanna into Wayne county which the coastal storms for some reason do not cross and which when the Ohio valley storms reach this section they have warmed to such an extent that they can contain more moisture which, together with this less elevated locality, accounts for decreased precipitation throughout this area and demonstrates both the effects of less elevated sections on cyclonic storm and precipitation.

WEATHER

Weather is the term used to express the changes in temperature or heat and cold, the changes from dry to wet, or rainy weather, clear or sunshiny to cloudy and humid weather, any or all of which may occur from day to day. It must be evident to all who have studied the subject of weather that it modifies the general effects of latitude, altitude and large bodies of water and is a factor in determining the climatic conditions of any area or country. These changes in the weather are produced by the changes in the direction of air movements or the motion of the air. The air movements are always toward areas of low pressure, that is where the air becomes lighter and begins to rise, and as this tendency becomes intensified, air from all directions flows toward this general center of low pressure, from which the air rises as an enormous column from whence it spreads out in counter currents in the upper atmosphere. Some of these low pressure areas toward which the air moves and which develop into cyclonic storms originate in the Pacific Ocean, others in the northwestern part of this country while others begin in the southwest. Usually the storms that originate in the northwest move

in an easterly direction over the northern United States or Southern Canada over the Great Lakes and down the valley of the St. Lawrence. Sometimes northern and western Pennsylvania receives some of the rain from these storms, but the greater part comes to the western part of this State from the storms which originate in the southwest and move eastward and northeastward across the United States,

As previously stated the air moves toward the area of low pressure from all directions. The currents coming from the south and southeast in Pennsylvania are warm and moisture laden and, as previously indicated, warm air has a greater moisture holding capacity than cold air, therefore, when these warm moisture laden currents coming from these directions strike the colder air currents coming from the north they become chilled and clouds are formed and in the onward movements of the air more chilling occurs and rain begins to fall and by the eastward movement of the cyclone new territory is invaded and a continuous supply of moisture is furnished by the inflowing southern air and cloudy and rainy weather prevails. On account of the spiral motion of the eastward moving cyclone the course of the winds move round to the east or even to the northeast of the low pressure area until they are cooled sufficiently to cause precipitation and the area of continuous rain or snow fall are east or northeast of the low pressure. As previously indicated, the universal movements of air currents toward the area of low barometric pressure brings the cold winds of the north down into this area and as these currents in coming in contact and mixing with the warmer current are warmed and their moisture holding capacity increased and any clouds they may contain are dissipated in consequence of which the air currents coming from the north which because of the eastward spiral movements of the cyclone are changed to the northwest winds cause clear and colder weather to follow the cyclone, while that which preceeded the storm was warm sometimes sultry in summer time, cloudy and rainy. Not only do these cyclones bring rain and changes in temperature, but there is an occasional tendency for these storms to follow in the wake of the preceeding storms and in the region north of the central path of the cyclone during such seasons will have an unusually large rainfall while the region south of the path will have a very light rainfall and in this way they become the agencies of producing wet and dry seasons in certain sections of the State especially in those sections in which the precipitation is the lightest and because of which crop yields are not up to what they would have been had there been more precipitation. Especially is this true of the southeastern section.

But while a deficient supply of moisture will limit crop yields, yet usually heavy rainfall throughout the growing season will frequently

produce a lowering of the temperature, especially in the northern part of the State and on the higher elevations, that there may be frosts during any month of the year except July and August and such hot weather crops as corn, and the soja bean, the cow pea and others can not thrive though the moisture supply be abundant.

The late frosts in the spring and the early frosts in the fall, which shorten the growing season that such crops as corn, the legumes above referred to and potatoes can not ripen, usually follows these cyclonic storms, accompanied with a heavy rainfall. But not only do these storms prevent agricultural crops from getting an early start or ripening, but when they come along during the blossoming season of the fruit trees an entire season's crops may be destroyed in one night by frosts, especially in low places.

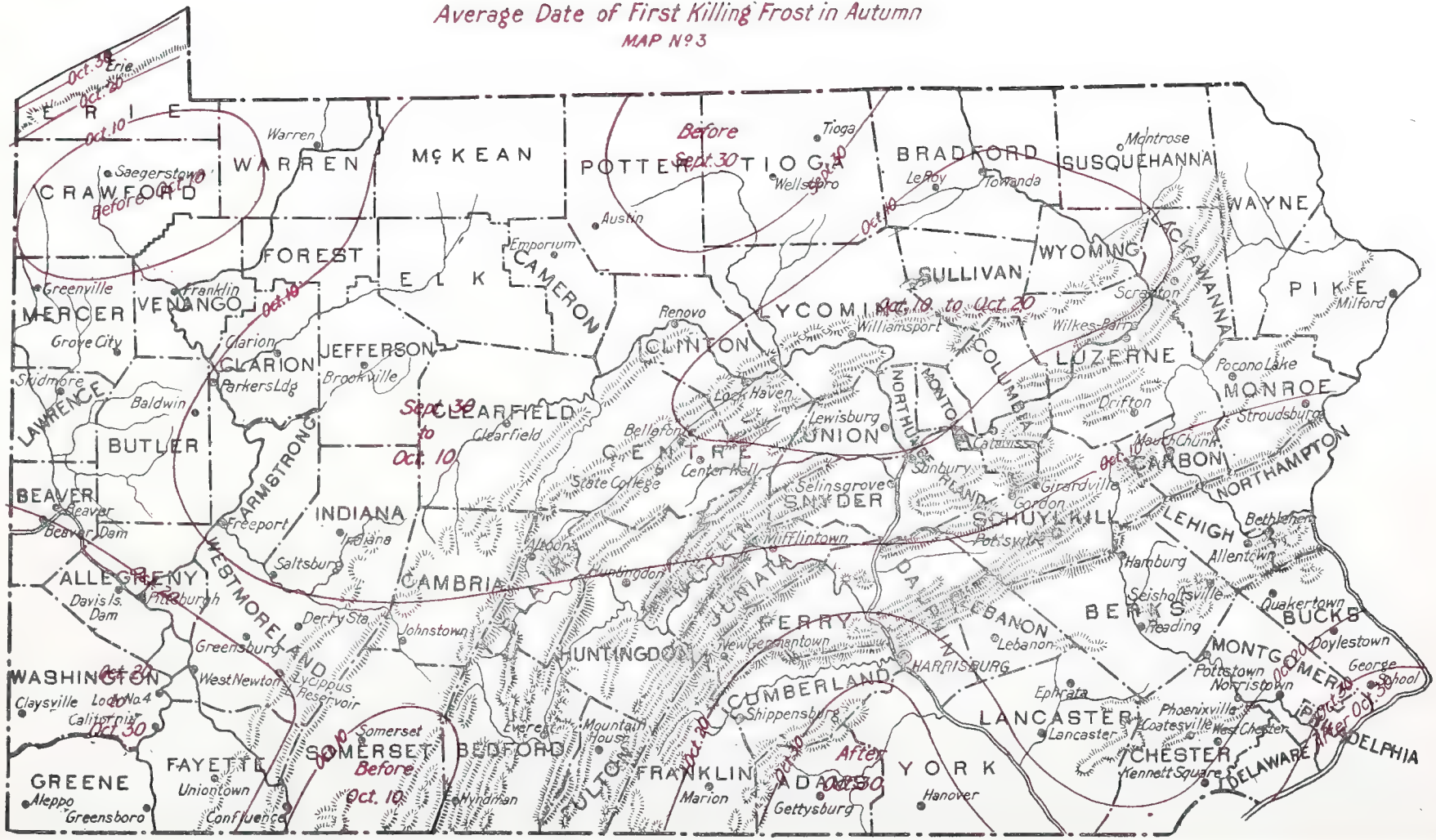
FROST AND AIR DRAINAGE

The cold air coming from the north and the northwest following these cyclonic storms becomes slightly warmer as it moves southward and acquires a larger water holding capacity, and, therefore, takes up from the soil some of the moisture from the previous rains and chills it, while at the same time the soil looses heat by radiation during the day as well as through the clear air on still nights and in this way the soil becomes cooler than the air immediately above it, and in consequence this lower stratum of air gives up heat to the soil by conduction and becomes colder and denser or heavier than the air a little distance above this lower stratum and, therefore, if this cooling occurs on an incline, the cooler and heavier air will flow down the slope and collect in hollows or valleys which will become gradually filled with colder and denser air in consequence of which late spring and early fall frosts occur much more frequently in valleys and hollows than on the higher slopes because as the denser air creeps down the hillsides, the warmer air from the higher elevations and higher and warmer layers is drawn down to the soil.

This process is known as air drainage and should be so thoroughly understood by the farmers in the various sections of the State so that wherever on a farm such areas exist, crops sensitive to frost should not be planted. Especially is this the case with fruit trees. As previously indicated, the cooling of the lower stratum of air is caused by radiation from the cooler soil, and in consequence, the water vapor holding capacity of this lower layer of air is diminished and dew is deposited, and if the ground is covered with a sod or any organic matter which radiates heat more rapidly than it receives it by conduction from the soil beneath and in this way making a temperature anywhere from 8 to 15 degrees lower; depending on the locality and the humidity of the air; immediately over the sod and

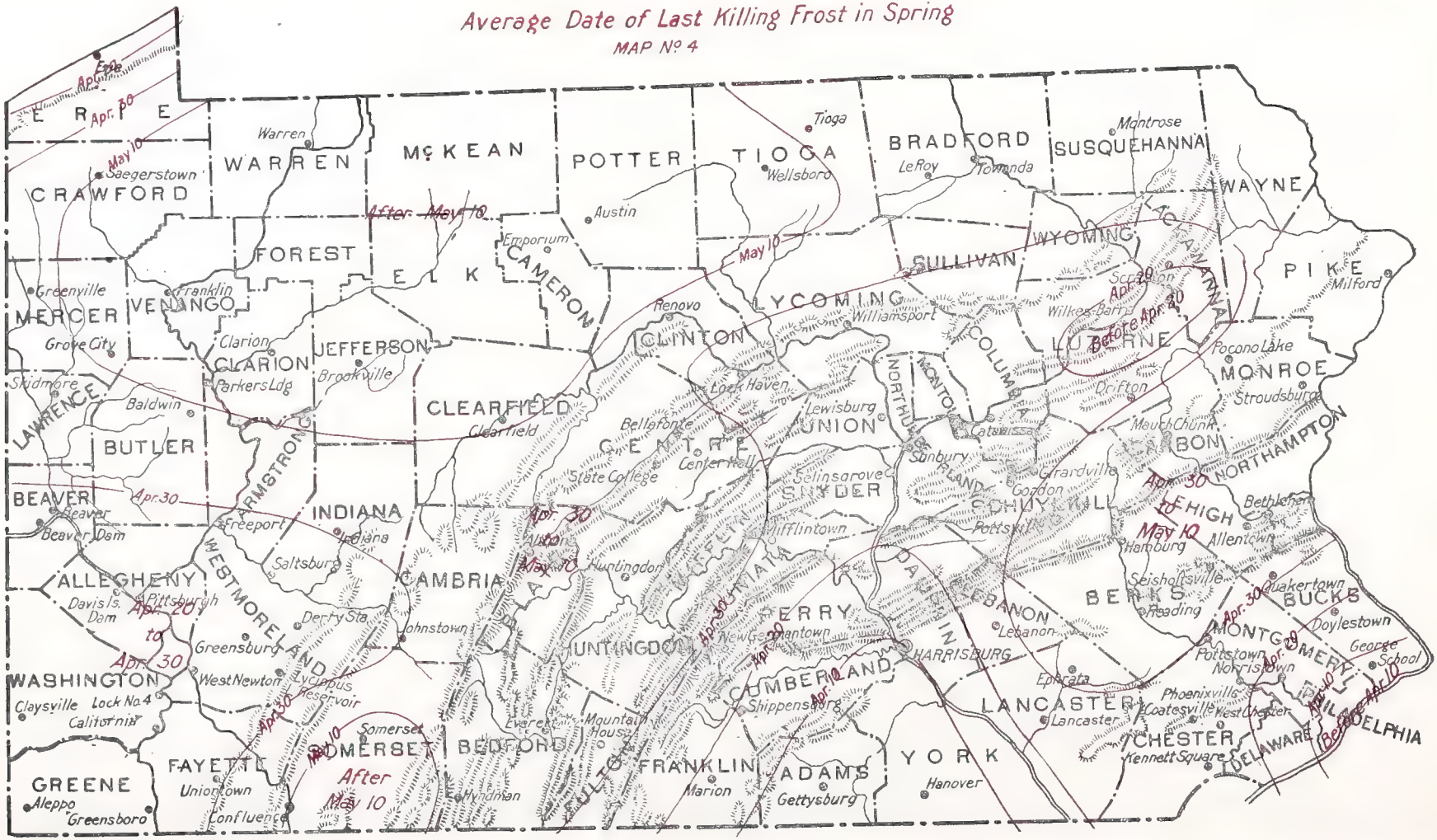
Average Date of First Killing Frost in Autumn

MAP No. 3



Average Date of Last Killing Frost in Spring

MAP No. 4



that on the surface of the bare ground a difference sufficient to cause a severe frost in the sod field or a field planted with vegetables and no frost at all on the bare ground.

As previously indicated, altitude and the distribution of land and water are the great factors that determine the climatic conditions of a region such as the annual mean temperature, the seasonal temperatures and to a certain extent the annual precipitation, the cyclonic storms act as modifiers of these general effects in such a way as in many places to determine the average length of the dates between killing frosts in the spring and the fall the average dates of which are given, in the following two charts.

THE GROWING SEASON

The average date for a number of years of the last killing frost in the spring and the first killing frost in the fall limits the growing season for any section of country of such crops as corn, potatoes and such clovers as the soja bean, the cow pea, the Canada field pea while such crops as fall sown wheat, rye and winter oats as well as red and alsike clovers and timothy and such root crops as rape and turnips will go on growing until the ground and plant juices freeze. The average date of the last killing frost in the spring chart No. 3 varies from before April 10 in eastern Bucks, Montgomery, Philadelphia and northern Delaware counties, and after May 10th, in Somerset, Clearfield, Jefferson, Clarion, Venango, Warren, McKean, Cameron, Elk and limited areas of adjoining counties, while the average dates of the first killing frosts in the fall according to chart No. 5, varies from after October 30, in eastern Bucks, Montgomery, Philadelphia and nothern Delaware and nearly all of York and Adams counties in the southeastern and southern parts of the State and before October 10th in Somerset, Crawford, western Warren and northern Venango.

The shortest average growing season, therefore, extends over four months, or 150 days, while the longest ranges from before April 10th, about Philadelphia and York until after October 30, in the same vicinities or, approximately, 200 days. Besides these differences in the length of the growing season or the time between killing frosts, there is such a difference in the seasonal temperature as will interfere with the successful raising of a considerable number of crops so that a rotation of such crops should be adopted for the various sections of the State as will yield the largest returns in human nutrition and at the same time improve the soil. The season between killing frosts is sufficiently long throughout the entire State to grow and ripen the various varieties of dent corns; but the seasonal temperatures are such on the higher elevations of the Allegheny

plateau and in the northern tier of counties that the highly developed flint varieties of corn for grain and the more luxuriant stalk producing varieties for silage yield the more satisfactory returns.

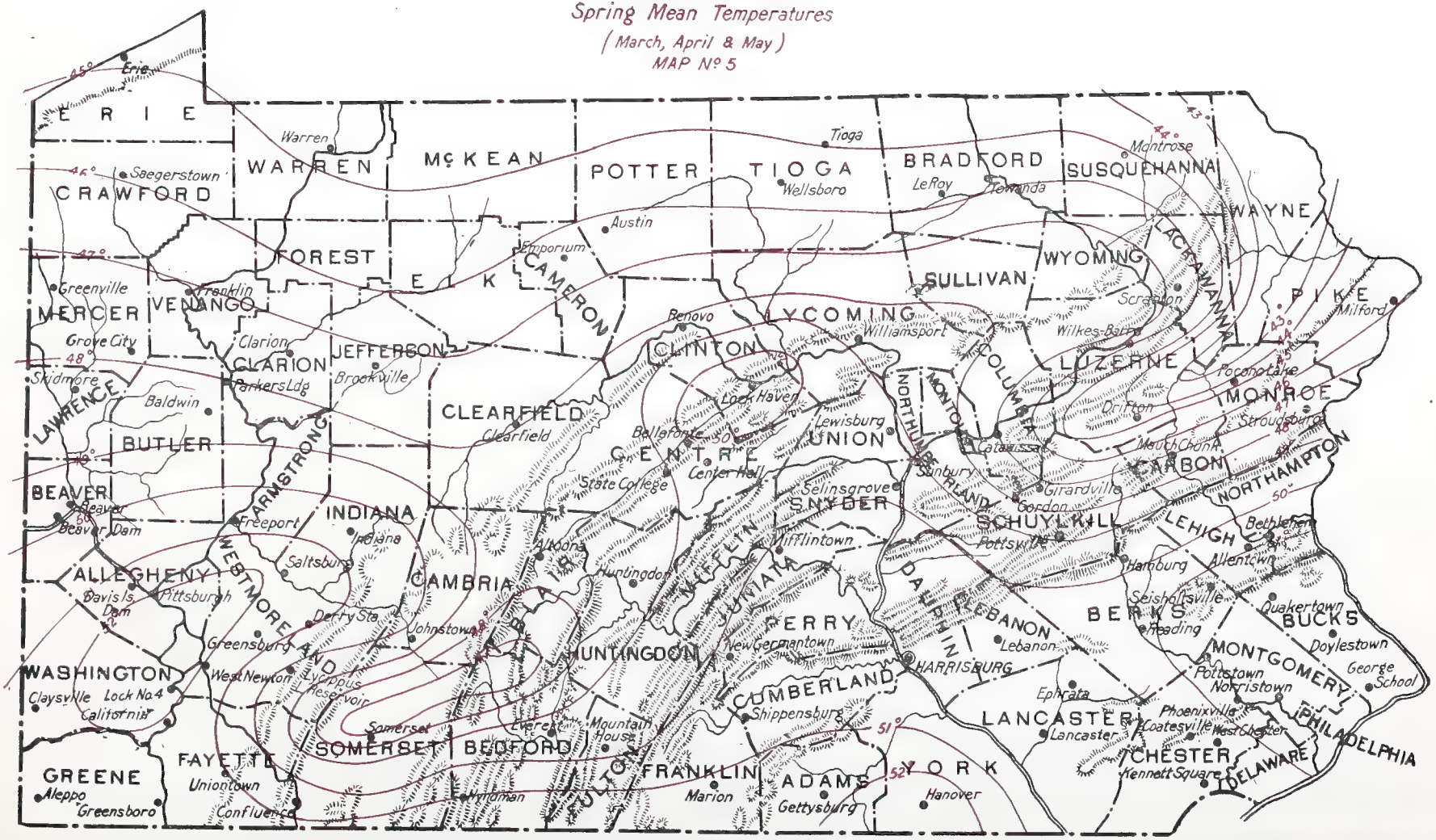
MEAN SPRING TEMPERATURE

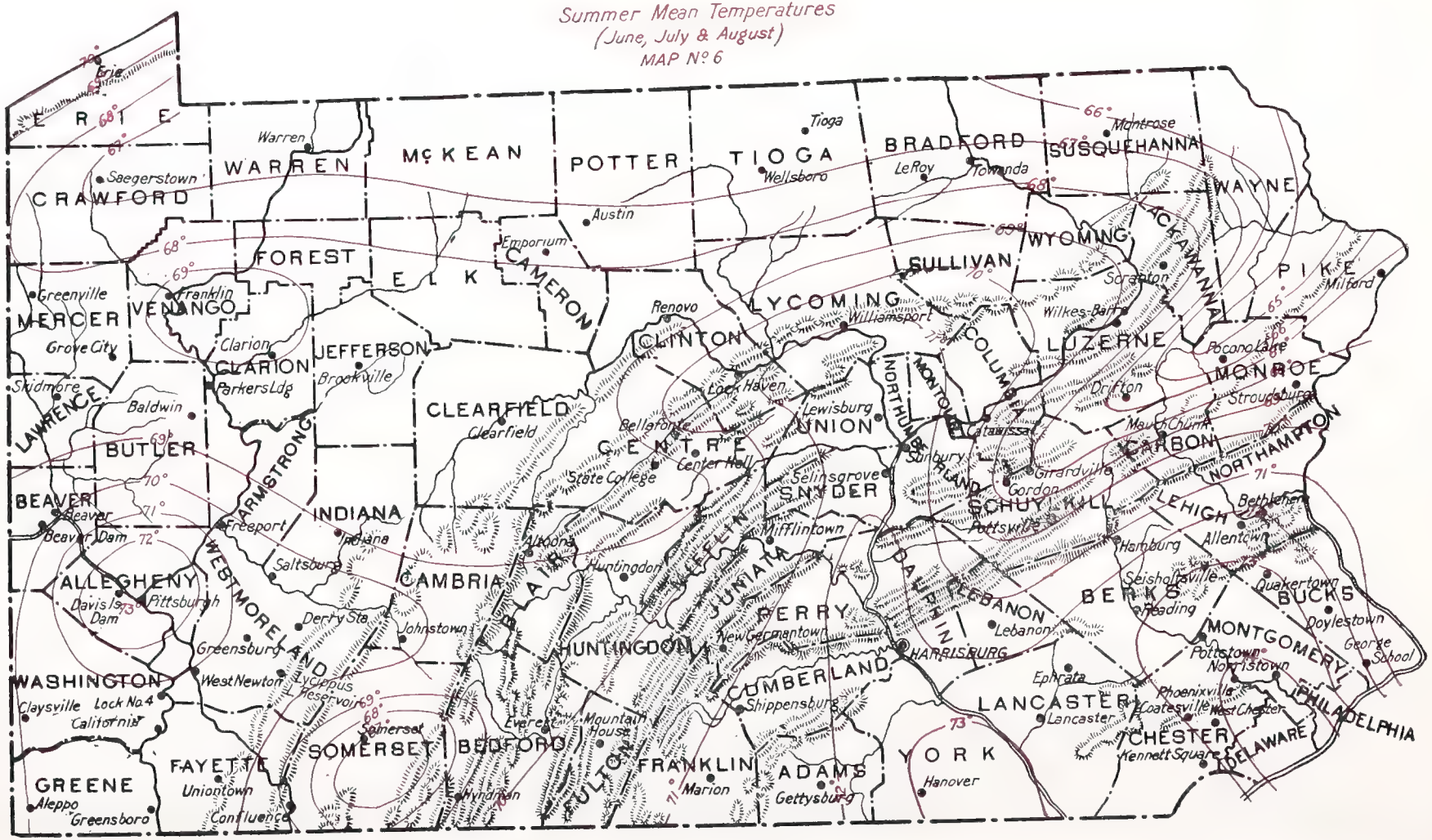
Map No. 5 gives mean spring temperature for the various sections of the State. Nowhere throughout the whole State does the average temperature fall below that required for fall sown plants such as wheat, rye the hay grasses and such clovers as red, alsike, crimson and the winter vetch and alfalfa to begin their growth, or the spring sown cool weather cereals such as oats, spring wheat, barley, spelts and others, and among the legumes, the Canada field pea to germinate and grow. On the higher elevations and in the northern tier of counties, March may be included with the winter months, because seldom can any agricultural operations be started anywhere north of the 48th degree area of temperatures before April or the middle of April, while in the southern part of the State, except on the Allegheny plateau or south of the 50th degree area of temperatures, cultivation can begin in March especially on the soils derived from the Hudson River shales and slates some of the Clinton, Salina and Chemung shales and slates which are not injured by being cultivated wet and are sufficiently warm for (the cool weather crops previously enumerated to which potatoes may be added) crops to germinate and usually keep on growing. Wherever such soil and climatic conditions prevail either fall sown cool weather cereals such as rye and winter wheat and cool weather legumes such as winter vetch and crimson clover among the short season and red and mammoth clovers among the perennials and early potatoes should be raised as well as oats and wherever possible the Canada field peas so as to get the benefit of the moisture derived from the snows and that from the excess of precipitation during the spring and develop a crop before the hot and dry weather of July and August comes and stops the development of these crops. In the southeastern and southwestern sections of the State, unless oats and Canada field peas are sown in March or before the middle of April, which is frequently possible on the gravelly or sandy loams of the rolling uplands throughout these sections so that they make their growth during the spring and early summer months, the peas frequently do not produce seed and the oats is light in weight except when the latter part of June and early July are abnormally cool, while oats, barley and spelts among the cereals and Canada field peas sown a month later in the northern section will, because of the cooler climate, invariably make larger yields of heavier and more highly developed seed. Wheat, which developes its grain and ripens it largely during the month of June in this southern section, is heavier than wheat that developes its

Spring Mean Temperatures

(March, April & May)

MAP No 5




Summer Mean Temperatures
(June, July & August)
MAP No 6
ERIE
MCKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
WARREN
CRAWFORD
FOREST
ELK
CAMERON
WYOMING
SULLIVAN
LACKAWANNA
PIKE
MERCER
VENANGO
CLINTON
LYCOMING
COLUMBIA
LUZERNE
MONROE
JEFFERSON
CLARION
LAWRENCE
BUTLER
CLEARFIELD
CENTRE
UNION
NORTHUMBERLAND
MONTOUR
CARBON
NORTHAMPTON
BEAVER
ARMSTRONG
INDIANA
SNYDER
SCHUYLKILL
LEHIGH
ALLEGHENY
WESTMORELAND
CAMBRIA
BLAIR
JUNIATA
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
WASHINGTON
HUNTINGDON
CUMBERLAND
HARRISBURG
MONTGOMERY
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
LANCASTER
CHESTER
DELAWARE
PHILADELPHIA
GREENE
Erie
Warren
Saegerstown
Tioga
Wellsboro
Austin
Emporium
Montrose
LeRoy
Towanda
Scranton
Wilkes-Barre
Milford
Greenville
Franklin
Grove City
Clarion
Parkers Ldg
Brookville
Renovo
Williamsport
Pocono Lake
Skidmore
Baldwin
Clearfield
Lock Haven
Lewisburg
Bellefonte
Center Hall
State College
Selinsgrove
Sunbury
Catawissa
Mauch Chunk
Stroudsburg
Drifton
Girardville
Gordon
Pottsville
Bethlehem
Allentown
Beaver
Beaver Dam
Freeport
Indiana
Saltsburg
Altoona
Huntingdon
Mifflintown
Harrisburg
Reading
Lebanon
Seisholtzville
Quakertown
Doylestown
George School
Davis Is. Dam
Pittsburgh
Derry Sta.
Johnstown
Greensburg
New Germantown
Ephrata
Lancaster
Pottstown
Norristown
Phoenixville
Coatesville
West Chester
Kennett Square
Claysville
Lock No. 4
California
West Newton
Lycoming Reservoir
Somerset
Everett
Mountain House
Shippensburg
Hyndman
Marion
Gettysburg
Hanover
Aleppo
Greensboro
Uniontown
Confluence
70°
71°
72°
73°
69°
68°
67°
66°
65°

grain during the latter part of June and ripens it in July, while wheat developed and ripened during July in the northern or higher and cooler sections of the State is equally as heavy and yields as well as in the southern section while in what might be termed the transitional areas in which the mean spring temperatures range from 50 degrees down to 48 degrees the developing and ripening season for the cereals such as wheat, rye, oats and barley and the cool weather clovers should wherever soils are adapted for raising these crops be the most perfect.

SUMMER MEAN TEMPERATURE

Map No. 6 gives the summer mean temperature or that of June, July and August. All the temperature areas from 74 degrees down to 69 degrees pass out of the State to the southeast or south except a small area in Washington, Allegheny and Westmoreland counties where the areas of 71, 72 and 73 degrees are confined to a limited section. The summer mean temperature areas of 70 degrees extends from east of the Allegheny Mountain in Bedford county as far north as Clinton, Lycoming, Sullivan, Wyoming, western Luzerne, Columbia, Montour, Northumberland, Union, Snyder, through Schuylkill, Carbon and northern Northampton into New Jersey, while the same temperature area west of the Allegheny embraces all of Greene, Fayette, eastern Westmoreland, southern Armstrong and Butler, eastern Beaver and all of Washington except the northeastern part. In the center of this latter area the summer temperature rises to a mean of 73 degrees. These areas of higher temperatures are confined largely to the areas of the lowest precipitation. This is especially true of the Pittsburg area. The area between the 69 degrees and 68 degrees equal temperature lines or summer isotherms are the normal-limits in which any but the ninety to a hundred day varieties of dent corn can be ripened and therefore the large yielding, highly developed flint varieties should be raised for grain and the large roughage or silage producing varieties for silage. A rotation of crops should be arranged in such a way as to avoid raising corn in the hollows or in such localities where frosts are likely to occur after the cyclonic storms and so limit the growing season so that corn will not ripen.

What has been said under the discussion of spring mean temperatures in the northern and higher elevations and their adaptation for starting the growth of fall sown cool weather cereals and leguminous crops as well as for sowing and planting the cool weather spring crops such as oats and barley and the Canada field pea and potatoes and their adaptation for starting these crops is true of the adaptation of the summer mean temperature for developing and ripening summer crops. Rye is one of the fall sown, cool weather cereals which seems

to thrive especially well and yield large crops wherever soil conditions are right, along the areas from the 69 degrees down to 67 degrees isotherms, and is one of the cereals which it seems should be more largely raised because for its adaptation as a feed for horses and its high feeding value. But oats is without question the best adapted cereal for these northern and higher elevated areas, and wherever this cereal yields from 50 to 70 bushels per acre it should occupy the leading position in the rotation, and where the Canada field pea and oats can be grown together to ripen for grain or to be made into hay so that a soil improving crop could be raised with oats the soil exhausting crop, this should be done both for the benefit of the soil and the splendid grain and roughage feed such a combination makes. The small cereal grains, the grasses and clovers grown for seed in the northern part of the State have strong vitality which is due to the climatic conditions under which they ripen. The areas throughout which the summer mean temperatures fall below 67 degrees, which is very limited in Pennsylvania, is well adapted for raising the pasture and hay grasses as well as oats and Canada field peas, and wherever the soils are derived from the Catskill red shales, winter wheat, and it seems to the writer, spring wheat should yield paying returns.

According to those who have studied the question, the summer mean temperature areas below 67 degrees come within the summer temperatures best adapted for cheese dairying which has been in the past a more extensive industry than at present but which because of the development of varieties of large silage yielding corn and the possibility of storing large quantities of a highly nutritious and succulent roughage by means of which with a grain ration of oats and Canada field peas which can be produced here or by the purchase of highly nutritious by product feeding stuffs at such prices as to yield paying returns, the more ready cash returning butter and milk dairy has displaced the cheese dairy even throughout this climatically adapted district. While butter and milk dairying has displaced cheese dairying in the climatically adapted cheese dairying areas, milk dairying has invaded the butter dairy district and is threatening to displace it because of the demand for milk by the large cities within reach of these districts and because as much or even more can be realized for the milk with less efficient labor and with less labor. The area north of 70th degree equal temperature line should because of the somewhat climatically limited crop, accommodating and producing capacity be devoted to butter dairying, the butter milk fed to hogs or calves and the butter, the hogs and the baby beef made the money crop and all the excrement together with the straw and the soil improving crops returned to the soil so as to maintain its fertility. Throughout this area, more especially in the southern part, the 110

day varieties of Dent corn will ripen and with careful seed selection and cultivation and by raising such soil improving crops as crimson clover, vetch, red, alsike, Mammoth and sweet clover and alfalfa the yield of this crop can be made twice as large as they now are throughout this region. In the northern part of this area as previously indicated a highly developed flint corn could likely produce large yields. The southern area or the area including the summer equal mean temperature lines of 70 degrees and above embraces all the southern counties except Somerset and extends from Bedford county northeastward into Clinton, Lycoming and Sullivan and includes all the counties south of these in the eastern central section and all south of the southern part of Schuylkill and Carbon and south of Monroe, and in the southwestern section, the area includes all of Greene, Fayette, Westmoreland, Allegheny, and Washington and small areas of several adjoining counties.

Throughout this area, except a small section, including Northampton and Lehigh and Berks counties, the average date of the last killing frost in the spring comes before April 30, and the first killing frost in the fall, October 10th, and after that date, making the season between killing frosts from 150 to 175 days in the northern section and from 175 to 200 days in the southern but especially the southeastern which with a summer mean temperature of 70 degrees and above makes this whole area climatically and wherever the soils are derived from the limestone, the shaly limestone, the micaceous exposures, the limy Clinton shales, the Salina limy shales, the Lower Helderberg limestone, the limy Marcellus with a few areas of the Chemungs, agriculturally one of the best corn growing sections in the United States. The northern and central sections of this area as has been intimated under the discussion of spring mean temperatures are climatically splendidly adapted for wheat raising, which is true of the southern section when the early ripening varieties are raised because these will develop and ripen largely before the hot weather for corn making begins. But corn is the most valuable cereal that is being grown throughout this area and should, therefore, occupy the position of advantage in the rotation.

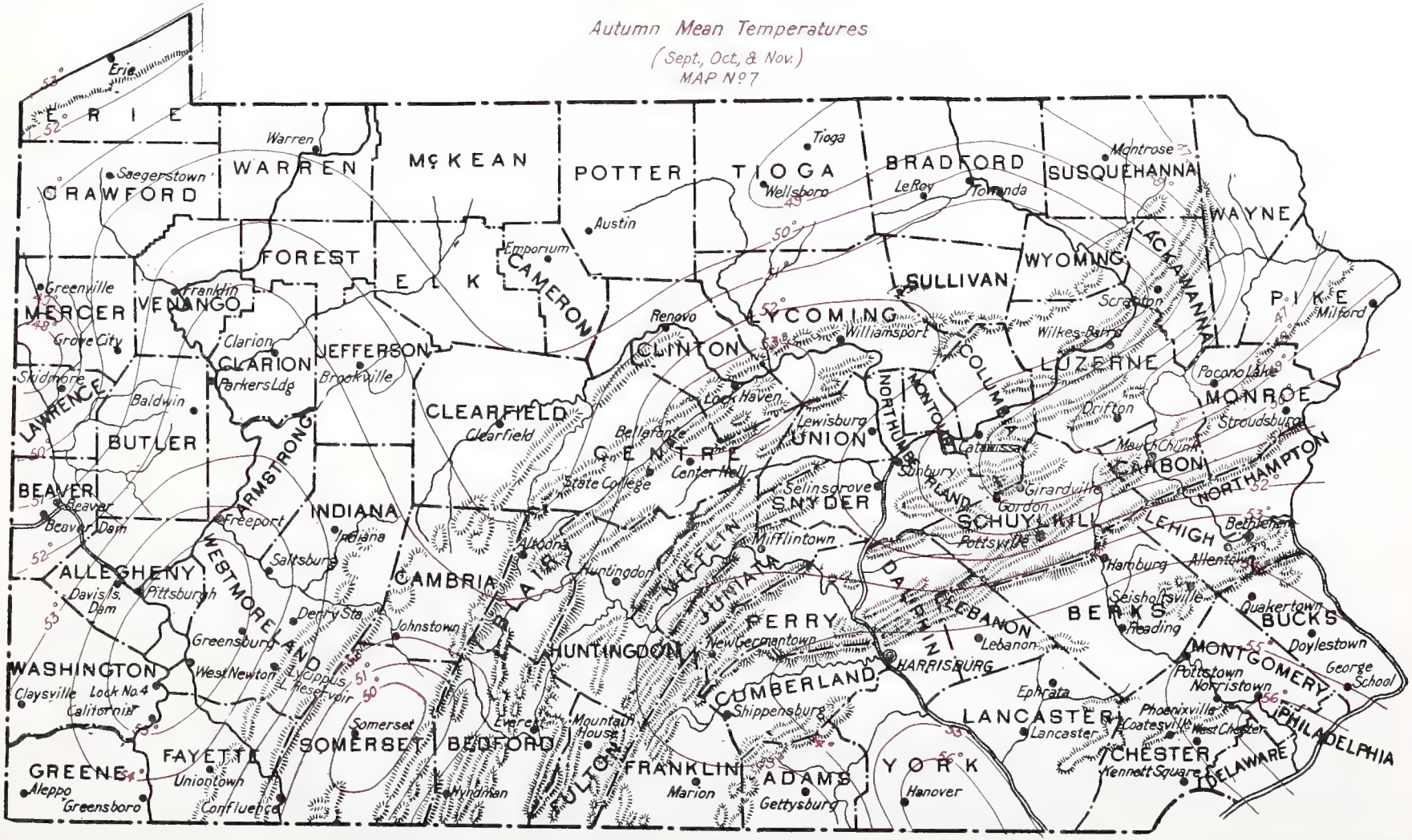
Wherever the farm manures are applied on the grass sod, the fertility contained in this manure is made available gradually and built up into the roots, stems and leaves of the grasses and clovers that should make up the sod, and when the sod is plowed up and the agencies of decay are assisted in their operations of making available the fertility contained in the sod, by intensive cultivation, especially of the loamy and clayey soils, before and after planting the corn, and corn in addition being a coarse feeder makes this the advantageous position in the rotation for this crop. With types of Dent corn developed and adapted so that they will take up the entire

corn growing and ripening periods for the various climatic and soil conditions of the various sections of this area, yields of corn can be increased to approximately twice what they now are. Another thing that can readily be done throughout these areas and should be done throughout the whole State is, that a growing crop can be maintained on the land at all times.

Just what these crops should be whether a legume or not depends on the rotation, its purposes and the location in the area. The rotation of crops grass, corn, oats and wheat and then back to grass now followed throughout this whole area, except in the southern part where oats have not been yielding satisfactory returns, wheat has been and is now being sown in the corn fields after the corn has been harvested usually without plowing the corn stubble and this wheat is followed with wheat and then with grass. The prevailing opinion among farmers throughout the area in which corn is followed with oats and which is a very desirable crop, is that it does not pay to sow any of the legumes with the corn after the corn has developed to such an extent that it is no longer benefited by cultivation.

This opinion is certainly not founded on practical experience and, therefore, may or may not be correct; but whether correct or not it does not preclude the necessity and the possibility of having a growing crop on the soil at all times. Therefore if some of the legumes can not be raised, certainly other crops such as rape, the cow horn turnip or some other of the turnip family which will grow long after the first killing frost and will take up and hold the fertility made available after the corn no longer needs it as well as add large quantities of organic matter to the soil, can be raised. If, in connection with these crops, a clover is raised with the oats and this plowed down after the oats is harvested and clovers raised with the wheat, the land can be improved and the returns increased. In the southern section of this area, previously referred to, in which oats unless sown in March or early April does not yield satisfactory returns, and because of which and also to have a growing crop on the land the corn stubble has been sown with wheat unless considerable quantities of commercial fertilizer are applied has not yielded inviting returns.

It is a question among the farmers throughout this section whether large returns could not be obtained by following different methods. Raising rye or an early ripening variety of wheat has been tried, and these crops followed with cowpeas, and these plowed down early in September with splendid results in the crop of wheat following. In several cases that have come to the writer's knowledge, the corn field after the corn was no longer benefited by cultivation was sown with grass, timothy, red and alsike clovers and alfalfa and splendid


Autumn Mean Temperatures
(Sept., Oct., & Nov.)
MAP No 7
ERIE
MCKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
WARREN
CRAWFORD
FOREST
ELK
CAMERON
MERCER
VENANGO
CLARION
JEFFERSON
LYCOMING
SULLIVAN
WYOMING
LACKAWANNA
PIKE
LAWRENCE
BUTLER
ARMSTRONG
CLEARFIELD
CLINTON
CENTRE
UNION
NORTHUMBERLAND
MONTOUR
COLUMBIA
LUZERNE
MONROE
BEAVER
INDIANA
SNYDER
SCHUYLKILL
CARBON
NORTHAMPTON
ALLEGHENY
WESTMORELAND
CAMBRIA
BLAIR
MIFFLIN
JUNIATA
PERRY
DAUPHIN
LEBANON
LEHIGH
BERKS
BUCKS
WASHINGTON
HUNTINGDON
CUMBERLAND
HARRISBURG
MONTGOMERY
GREENE
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
LANCASTER
CHESTER
DELAWARE
PHILADELPHIA
Erie
Warren
Saegerstown
Tioga
Wellsboro
LeRoy
Towanda
Montrose
Austin
Emporium
Greenville
Franklin
Grove City
Clarion
Parkers Ldg
Brookville
Renovo
Williamsport
Lock Haven
Wilkes-Barre
Scranton
Milford
Pocono Lake
Drifton
Stroudsburg
Mauch Chunk
Skidmore
Baldwin
Clearfield
Bellefonte
Lewisburg
Catawissa
Sunbury
Girardville
Gordon
Beaver
Beaver Dam
Freeport
Indiana
State College
Center Hall
Selinsgrove
Mifflintown
Pottsville
Bethlehem
Allentown
Hamburg
Seisholtzville
Reading
Quakertown
Doylestown
George School
Pottstown
Norristown
Phoenixville
Coatesville
West Chester
Kennett Square
Davis Is. Dam
Pittsburgh
Saltsburg
Altoona
Huntingdon
Derry Sta.
Johnstown
Greensburg
West Newton
Youghiogheny Reservoir
Claysville
Lock No 4
California
Somerset
Everett
Mountain House
New Cumberland
Lebanon
Ephrata
Lancaster
Shippensburg
Claysville
Aleppo
Greensboro
Uniontown
Confluence
Wyndman
Marion
Gettysburg
Hanover

crops of hay were produced and the fertility maintained. But a practice that seems safer throughout this section, especially on the soils derived from the Micaceous rock, limestone, limy shale, shaly limestone, and other shales and some sandstone, is the seeding of crimson clover which thrives well and can be successfully started after corn is no longer benefited by cultivation or such crops as rye and crimson clover or rye and winter vetch can be started after the corn is cut. The rye or the rye and winter vetch can be pastured or cut for hay or silage and the rye stubble or the rye and winter vetch stubble, or crimson clover and rye, if these had been sown, plowed down and the land planted with soja beans. The soja bean after these have been raised for several years will yield larger bean and straw crops than wheat will yield wheat crops and will sell at a higher price than wheat and at the same time they will improve the soil while wheat exhausts it.

In the southern section of this area the long season cool weather legumes such as red and alsike clovers and alfalfa thrive as well as the hot weather mammoth and the short season cow peas and soja beans. With the possibility of raising such an array of soil improving crops, any phase of grain farming or the livestock industry can be sucessfully undertaken and with the right use of the farm manures the land can be improved. It is a question whether the soja bean should not take the place of wheat and oats in the rotation and the farmers of this section supply the farmers of the northern areas with this high protein food and the farmers of the northern and higher altitude areas supply this southern and lower altitude farmer with oats. This might become a profitable exchange of crops. This south-central, southeastern and southern area is also the tobacco section of this State and all the tobacco which has become recognized as one of the most profitable crops is being raised here. The mean temperature of the whole State is sufficiently high for such crops as are not harmed by the first killing frosts among the legumes, the red, alsike, Mammoth and crimson clovers and the winter vetch, and among the cereals, rye, wheat, winter oats and barley, and among other crops, rape, cowhorn and other turnips.

AUTUMN MEAN TEMPERATURE

The mean temperature of the three fall months, September, October and November, is higher by from two to four degrees, probably due to effects of the Atlantic Ocean in the southeastern, eastern and northeastern areas and eight degrees higher along Lake Erie, than in other sections of the State demonstrating, as previously indicated, in a remarkable way the equalizing effects of large bodies of water on the seasonal temperature of a country. The first killing frosts, because

of the larger heat storing capacity of water and the giving up of this heat day and night to the cooling air, is delayed until October 30th, the same as in the vicinity of Philadelphia and the northern part of Delaware nearly 200 miles further south making it possible for such fruit crops as grapes, climatically adapted to this northern section, to accumulate a large amount of sugar and attain a flavor which, under sudden fluctations of temperature such as occurs away from large bodies of water would not be possible.

Similar variations as those in the eastern part occur in a small section in the southwestern part of the State where the first killing frost is staid until October 30, probably due to less precipitation. A small section in which the fall and spring mean annual temperatures are similar occurs in the northeastern part of Lawrence and the southwestern part of Mercer counties, probably due to the fact that this section is uninfluenced by the moderating effects of water and is entirely subject to inland conditions. The mean fall temperatures of the whole State is sufficiently high except probably in those areas where killing frosts occur by or before September 30; which are very limited, for such crops among the legumes as crimson, red, alsike and mammoth clovers and the winter vetch and among the cereals, rye, winter wheat, oats and barley and among other crops rape, cow horn turnips and other turnips as well as a number of varieties of beets to go on growing throughout the greater part of October, and in the areas embracing the 52 degree isothermal line and from there up growth of these crops will continue especially in the southeastern section of the State frequently until the middle and toward the end of November.

The climatically adapted sugar beet area of the United States, according to Bulletin No. 52, U. S. Department of Agriculture, 1908, by Dr. H. W. Wiley, passes along the 70 degree isothermal line, including all of the moderately rolling sections of the northern part and the more fertile soils of the higher elevations of Somerset county, in the southern part. These areas and their soils are not, as a whole, adapted for growing beets containing a high percentage of sugar, but in a general way the more rolling sections of the glaciated area, especially where the shaly Catskill and the coal shale formations together with the glaciated material form the soils, of a succulent and highly nutritious foods. Such a tonnage can be raised on four or five acres as will enable those who do not care to make the expense of building a silo stored and in a cheaply constructed beet cellar under the barn bridge or close to the barn or feeding shed, that will carry through a herd of from ten to twenty animals and keep them in splendid condition; and what is still more desirable, this can all be done with less work than filling a silo. As

nigh as twenty tons of beef have been raised per acre in the southeastern section of the State where climatic conditions are not so favorable.

The areas where comparatively dry and cool weather prevails during the ripening season are best adapted for the accumulation of a large percentage of sugar. Dr. Wiley, in Bulletin No. 52 (revised) U. S. Department of Agriculture, 1899, says: "It is evident, however, that in the northern and western portions of the State, where suitable soils can be found, the culture of the sugar beet may be introduced under the most favorable conditions and with every prospect of success." Crimson clover can be started before the beets are harvested and made a cover crop for the winter. Under the discussions of the origin of soils it was stated, that the soils are brought into existence through the energy of the sun, and also that plants are storers up of the sun's energy and, therefore, whenever possible plants should be kept on the soil at all times to take up the fertility as it is made available and store it together with the suns energy as long as it is not too cold for plant juices to carry on this operation, and after this period, to hold these until the agencies of decomposition can again make them available for future plant growth. The early fall temperatures ranging from the isothermal or equal temperature line of 50 degrees and upward are splendidly adapted for ripening red, alsike, Mammoth clovers and alfalfa seed as well as buckwheat, and wherever possible, especially wherever the sod is to be plowed for corn, should these seeds be ripened and hulled and the straw returned to the soil and the seed used for raising these legumes. The area from the isothermal or equal temperature line of fall mean temperature of 50 degrees and upward are also adapted for ripening corn which throughout these areas is the most valuable cereal crop and for starting the winter cereal crops such as wheat, rye and winter oats and barley.

WINTER MEAN TEMPERATURE

At no place in Pennsylvania is the winter temperature so low as to injure the crops previously suggested as adapted to the various sections of the State and the air normally at all times contains sufficient humidity during the winter to protect the moisture of fruit trees so that even low temperatures do not harm them. Like the annual mean temperature, there is a difference of ten degrees, between 23 degrees the lowest winter temperature in the northeastern part of the State and 33 degrees the highest in the southeastern part.

THE ADAPTABILITY OF THE CLIMATIC CONDITIONS OF PENNA. FOR FRUIT GROWING

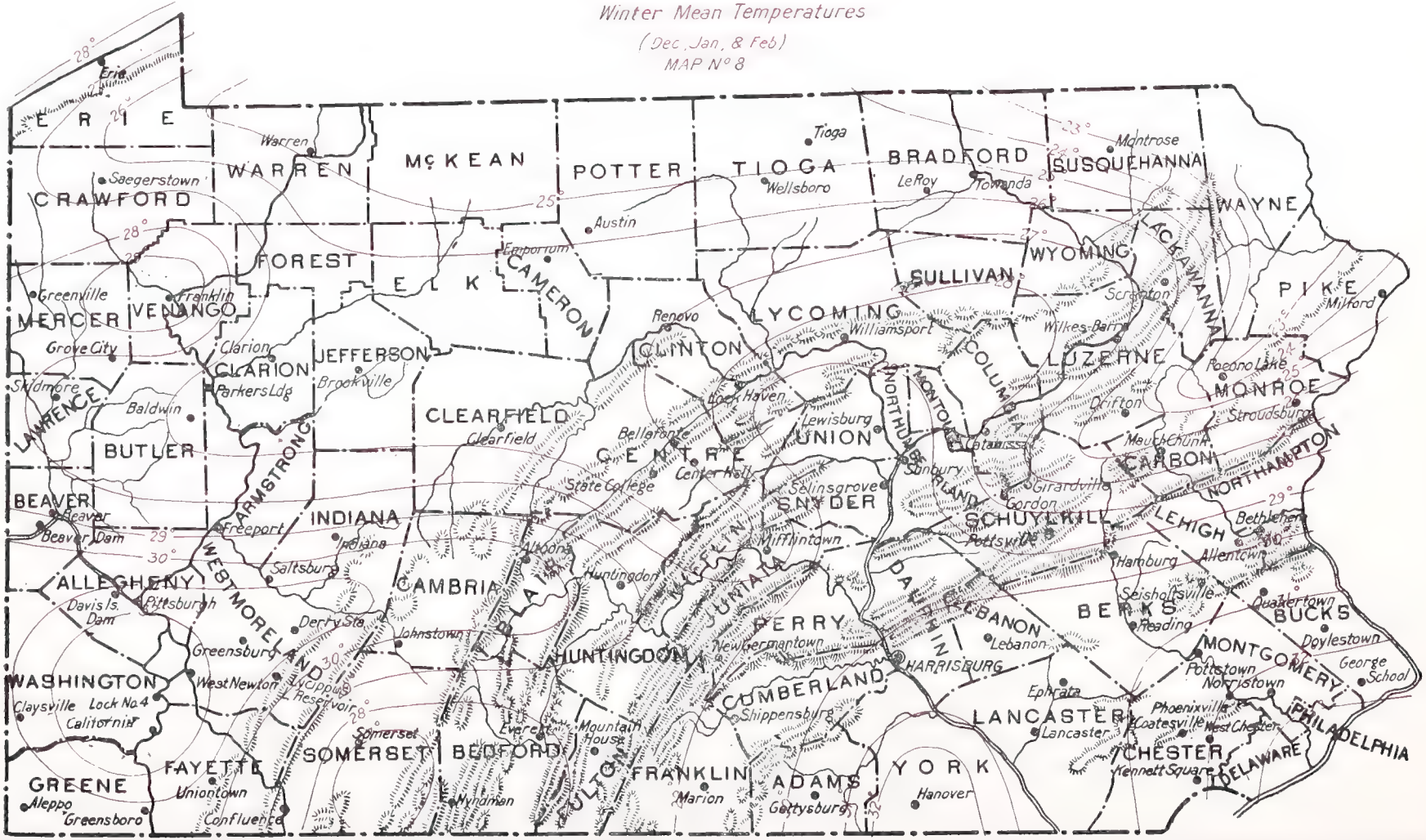
Much has been written on this subject and it is only necessary here to refer to the climatic conditions as they appear from the charts previously discussed. The average date of the last killing frost in the spring ranges from April 10, in the southern and southeastern part of the State, except in a limited section in Somerset county and in parts of Crawford, Warren, McKean, Potter, Cameron, Elk, Forest, Venango, eastern Mercer, northern Butler, Clarion, Jefferson and northern Clearfield Counties, to May 8, in the remainder of the State, which, according to the date of the first killing frosts, makes a growing season in all these higher elevations and northern areas except in a limited section in Potter and Tioga counties of from 140 to 150 days. This is a sufficiently long season to ripen a crop of fruit and to grow and ripen a wood growth with sufficient strength to produce a crop of fruit every season providing the fruit is thinned and the best types of soil improving crops that can be grown under prevailing climatic conditions are raised and allowed to remain on the soil. In the areas in which the dates of the last killing frost in the spring vary between April 10, and April 30, and the first killing frost in the fall between October 10, and October 30, larger crops of well developed, highly colored, nicely flavored apples and peaches can be raised, providing the soils are adapted for fruit raising, than anywhere in the State.

Carbon county lies along the boundary of this area. This county contains a considerable acreage of Catskill and Catskill Chemung soils splendidly adapted for raising the best developed, highly colored, nicely flavored apples and peaches which together with the climatic conditions such as comparatively cool summers and long cool falls prevailing throughout this and parts of Schuylkill county should make this region one of the first fruit sections of the State. Both climatic and soil conditions combine to make the South Mountain area the great peach growing section of the State with a close second on the Clinton shales along the Medina and Oneida sandstone formation.

Winter Mean Temperatures

(Dec, Jan, & Feb)

MAP N° 8



CLASSIFICATION BY COUNTIES

PART ONE

PHILADELPHIA COUNTY

Agricultural operations were going on in this county prior to 1646, largely by the Swedes and the Dutch. Soon after the establishment of the colony, William Penn parceled out land among his followers, in areas of 200 acres, at a rental of a penny an acre.

The county contains 85,120 acres, of which 30,488 acres is farm land, and of which 26,013 acres is improved farm land. 3,607 acres were planted with corn in 1909, yielding 162,502 bushels; 244 acres were sown with oats, yielding 7,122 bushels; 1,142 acres were sown with wheat, yielding 26,862 bushels: 726 acres were sown with rye, yielding 13, 424 bushels; 1,540 acres were planted with potatoes, yielding 140,083 bushels; 5,420 acres were sown with all forage crops, yielding 9,106 tons of the various kinds of hay. Of the 26,013 acres of improved farm land, 12,679 acres were used in raising farm crops, while 13, 334 acres were not so used and were likely producing weeds. At this time, Philadelphia county had a population of 1,549,008 to feed, 3,524 cattle, 2,233 horses, 43 mules, 6,737 swine and 1,362 sheep.

The Delaware makes the southern, Poquessing Creek the eastern and Cobb's Creek the western boundaries of this county, with an irregular line between it and Montgomery county on the north. The soils of the county are derived from the Potsdam sandstone, along the northern edge, where this formation, together with the Syenitic group, makes a ridge north of Somerton. The Gneissic and Micaceous groups are exposed in the northern end of the county between Poquessing Creek, Chestnut Hill and Schuylkill River, and take part in the formations of the soils, while the soils south of this formation are derived from the Bryn Mawr gravel, the yellow gravel, Philadelphia birch clay and red gravel, the Trenton gravel and the recent alluvium along the river.

The soils derived from the Potsdam sandstone, the Syenitic and Gneissic group along the northern border of the county are like all the soils of this derivation, among the best apple soils in this section of the State; and where the trap rocks prevail in the more stony types, and where the Mesozoic remanents occur, are the best peach

soils in this State, producing vigorous disease resisting trees, which will yield large crops of well developed, highly colored, nicely flavored fruit. These soils will also produce the small fruits—strawberries, raspberries and blackberries.

The apple soils, previously referred to, are usually deeper with larger water holding capacity and in derivation similar to the soils of the South Mountain district which will produce vigorous disease resisting trees which yield large crops of well developed, highly colored, nicely flavored fruit. The more rocky, stony and steeply hilly soils, of which the area is small, of this derivation which do not wash readily, should be planted with apple trees with such practices of cultivation, mulching and raising of soil improving crops as practice will demonstrate to be best adapted for maintaining vigorous disease resisting trees that will yield large crops of well developed, highly colored, nicely flavored fruit. Such a condition has not been attained, but with the deep interest in apple and peach raising manifested throughout the State, such an attainment is not improbable, especially with such markets as exist here. The Micaceous shists and Gniessic soils south of this formation begin some distance east of Somerton, and extend in a southwestern direction to and beyond the Schuylkill River. The land is moderately and nicely rolling with deep, warm, loamy, early spring farming soils, with large water and fertility holding capacity, which seldom become too wet or too dry for crops to grow, adapted for raising all the regular farm crops. With the crop accommodating capacity, and the distributive water holding capacity, by means of which an excess of water is held in such a condition in these soils that plants can go on growing during wet weather, and enough is held when dry weather cultural methods are used for crops to thrive equally as well in dry seasons—these soils lend themselves to the production of crops that will thrive in the cold and cloudy, and the warm and sunny days of early spring, which will ripen in early summer and to crops that will thrive during the hot and frequent dry seasons of mid summer, and which ripen in early fall and to crops that can be started during the hot and dry season and be ripened in the later fall. With such conditions, the highest type of intensive agriculture can be developed with the dairy and other livestock industries, and in market gardening, and the largest crop returns realized both for feeding these animals and in market gardening that soil and climatic conditions make possible.

The soils derived from the gravels are equally as fertile or even more so, and while the soils cannot be farmed as early, the greater fertility, with a more tenaceous hold on the fertility in these soils, and the larger quantity they contain makes it possible for crops to attain a larger growth in a shorter time than the earlier farming

lands derived from the rock along the northern part of the county, except that such crops as alfalfa and fruits will not thrive as well in these soils as in the northern section. All the land available for agricultural and horticultural purposes in this county should be cultivated and used for the production of these crops to supply the great demand existing in Philadelphia and the surrounding cities and towns. The value of the land in this county is so high that only the most highly trained practical dairymen, market gardeners and fruit growers can make a success of any of these agricultural industries. But most of this land is so productive and so crop accommodating with deep, warm, early spring farming soils, with such a distributive capillary water holding capacity that dairying, market gardening, and where the fruit soils prevail fruit crops can be kept growing in these soils from early spring until late fall, or during the winter growing season, and handsome returns on both the investment, and for the labor can be realized on $5,000.00 an acre land.

DELAWARE COUNTY

Delaware county was not separately organized until 1789; but according to Egle's History of the Commonwealth of Pennsylvania, Page 35, plantations existed along the Delaware River as early as 1645, therefore some agricultural operations must have existed previous to this time, and all of the land that has been farmed constructively for 275 years, is as productive today as at any previous time. It contains 118,400 acres, of which 82,575 acres is land in farms, of which 67,559 acres is improved farm land; 9,525 acres were planted with corn in 1909, yielding 429,181 bushels; 5,508 were sown with wheat, yielding 122,925 bushels; 1,584 with oats, yielding 45,360 bushels; 337 acres were sown with rye, yielding 7,733 bushels; 2,436 acres were planted with potatoes, yielding 156,074 bushels; 16,314 acres were sown with all forage crops, yielding 31,906 tons of the various kinds of hay. At this time (1909) Delaware county had a population of 117,906 to feed, 16,265 cattle, 4,688 horses, 95 mules, 6,590 swine, and 1,475 sheep.

This county occupies the southwestern corner of the State bordering on the Delaware River, and on the State of Delaware. The soils of the county are derived from the Hornblend slate and Gneiss Syenite and granite, Philadelphia and Manayunk Mica shists, Chestnut Hill shists and slates, South Valley Hill talc, Mica slate, Serpentine and associated rocks, limestone, trap, ferruginous conglomerate, gravel and clay and recent alluvium.

The drainage of the county is accomplished by Cobb's and Darby creeks in the eastern part, Crum and Ridley creeks in the central part, and Chester Creek, with its western tributaries, in the central

western and western parts—all flowing into the Delaware River. The land in this county is some gently, some moderately and some steeply rolling. The soils are usually deep with large water and fertility holding capacity.

RADNOR TOWNSHIP

This township occupies the northeastern corner of this county, with the Montgomery county line for its eastern, and the Chester county line for its northern boundary. The soils of the township are largely derived from the disintegrated Syenitic and granite rock, the Chestnut Hill shists and slates, the so-called Hudson River or South Valley Hill talc, Mica slates, a small area of Serpentine, with still smaller areas of limestone and trap. The land is moderately rolling above the streams, while along the streams it is steep, with thin soils, with small water and fertility holding capacity as over against the deep, warm, early spring farming soils, with large water and fertility holding capacity of the rolling plains adapted for raising the regular agricultural crops, but especially adapted for raising wheat and corn among the cereals, of which they will produce large yields of splendid quality.

Among the legumes, the red, alsike, and Mammoth clovers and alfalfa yield abundantly. This latter plant seems to find an especially congenial soil environment in the deep, loamy gravels of Syenite and Granite origin, the Mica shist and the Hudson River group when some lime is added with the seeding. These soils are also splendidly adapted for raising truck or market gardening crops. They are usually loamy, warm and in good plant growing condition in the early spring, and when treated, as market gardening soils should be, will contain large quantities of moisture during the drier summer seasons. In the southeastern corner of this township is a section of clay soils which are fairly well adapted for raising market gardening crops or alfalfa, and when carefully handled will produce large yields of wheat and corn. In the southwestern corner the outcropping Serpentine enters into the composition of the soil with its usual detrimental effects. This same rock remains in the Chestnut Hill shist section, north, northeast and northwest of Radnor, while its evil effects are not as pronounced here because mitigated by the better effects of the shist rock. Still the forest trees, as well as the undergrowth and crops on the land that is farmed shows its baneful influences. In the northwestern part of the township the South Valley hills make a ridge with soils derived from a Micaceous rock usually as fertile as the soils previously discussed, and adapted for the raising of the same kinds of crops. South of the valley hills, or Micaceous rock referred to, and approximately a mile from the east-

ern boundary of the county, is an outcrop of limestone apparently of sufficient purity for use as agricultural lime, or when ground as carbonate of lime for these soils.

NEWTOWN TOWNSHIP

This township lies west of Radnor, with the Chester county line for its northern and partly for its western boundary. The land in this township is more rolling than Radnor, with fewer steep hillsides, because only one of the larger streams flows through the northeastern corner of the township and along its western boundary. Along these streams the steeper hillsides, referred to in Radnor township, occur, otherwise the land is rolling. In the southeastern corner of the township and along the southern border the soils are derived from the Serpentine rock together with the Syenites, making comparatively deep loams and gravelly loams with fair water holding capacity, but with their fertility affected by the deleterious influences of the intermingled Serpentine. Manure and organic matter derived from sods and green manuring crops together with some lime have very beneficial effects on these soils.

North of Fawkes' and Hunter's runs, the former flowing east into Darby Creek and the latter west into Crum Creek, the soils are derived from the Syenites, and are deep loams or gravelly loams with large water and fertility holding capacity, adapted for raising, as previously indicated, the regular farm crops, to which potatoes can be added. At Newtown Square, along the Philadelphia and West Chester Turnpike, north, east and west to Crum Creek, is a rolling section with deep, easily farmed, early farming soils which will produce providing the necessary soil conditions for a fall seeded, early summer ripening crop to begin its growth, or for spring seeding, early summer ripening crop as a hot weather soil improving crop, such as the cow pea after the first crops are harvested, to be used for forage or plowed under and the land again sown with an early summer ripening crop for which operation the seasons are amply long in this county. In the northern part of this township the land has about the same configuration as in the southern part with equally as deep if not deeper, soils derived from the Mica shists with large water and fertility holding capacity adapted for raising the same crops referred to in Radnor township or outlined for the Syenitic soils of this township.

EDGMONT TOWNSHIP

This township lies west of Newtown, with the Chester county line for its northern boundary. The soils of this township are derived from the Serpentine, Syenites and Mica shists. The Serpentine rock occurs in the northeastern corner of the township, and is a con-

tinuation of the same remanent occurring in the northwestern corner of Edgmont township, not referred to in the discussion of that township. The areas of this formation are small, but wherever even a remanent is left, the bad effects of this rock are noticeable as previously indicated. In the northwestern section of this township the same formation remains and extends in a larger area into Chester county where the formation is more fully discussed. On Crum Creek, near the eastern boundary of the township, Castle Rock, in derivation closely allied to the Serpentine rock, makes a prominent bluff, with rough and poor soil surroundings, but with rather romantic scenery. The Mica schist soils occur in the northeastern and northwestern parts of this township with one of the more moderately rolling formations in the vicinity of Edgmont, with soils adapted for raising such crops as indicated in Newtown township. In well nigh the whole of the central and southern sections of the township, the soils are derived from the Syenite rock with similarly loamy and gravelly loams as those previously discussed adapted for the raising of similar crops.

The underlying rock is exposed along Ridley and Crum creeks forming steep sides with thin or no soil while in the southern part of the township the rock exposures are numerous throughout the district, with stony land, and in many places thin soils, which makes farming difficult, and not so remunerative. The same rock is exposed at Howellville and its vicinity with similar soils. Here also occurs a clayey section to be discussed later. The more loamy and silty soils of these rocky lands can be maintained in permanent blue grass pasture if manured and limed occasionally, if not pastured to death, while the more gravelly and stony types, which are still more difficult to farm, can be planted with apples, peaches and the small fruit, such as raspberries, blackberries, etc., or they can be planted with the improved chestnut, the English walnut, or other species of nuts which it seems should be fostered on the hilly and rocky land of this county, and the same formation in Chester, Montgomery and other counties.

THORNBURY TOWNSHIP

This township lies west of Edgmont, on the Chester county line. The soils of this township are derived from trap, Serpentine, Mica schists and Syenitic rock. The trap rock occurs more particularly along the northern part of the township, and at Glenn Mills, where a large dyke occurs. West of this place, on the hills, the land is rolling with deep, loamy and silty soils and some gravelly loams derived from what seems to be trap and Mica schist rock, adapted to raising the crops previously referred to. The steep hillsides are usually rocky, while the soils of the less steeply hilly sections are

deep, stony loams with large water and fertility holding capacity adapted for peach and apple raising of which these soils will produce vigorous disease resisting trees, yielding large crops of well developed, nicely colored, well flavored fruit. This is only true of the trap and Mica schist derived soils of the hilly sections, and not of the loams and silty soils of the rolling uplands. East and northeast of Glenn Mills, in a limited area, the Serpentine rock enters into the formation of the soil with the same baneful effects as those previously discussed.

The Mica schists, in connection with which the trap rock occurs, occupies the higher elevations of this township with some rocky, stony and steeply hilly land along the streams, especially along Chester Creek, with comparatively deep soils, but difficult to farm, and many sections not adapted to farming but adapted for raising fruits and the various nuts above referred to. This hilly land washes and therefore hillside farming wherever the land is farmed, should be practiced or the land maintained in sod and planted with trees.

In the northwestern part of the township, in the vicinity of Thorntonville, is one of the more moderately rolling sections, with deep soils adapted for raising the same crops as the same soils of similar origin previously discussed. The soils derived from the Syenitic rock occupy approximately the central part of the township. The land above the streams is rolling with similar adaptations and capacities as those of similar soils discussed in the previous township.

BIRMINGHAM TOWNSHIP

This township occupies the western extremity of this county, with the Brandywine Creek for its western and Delaware State line for its southern boundary.

The soils of this township are derived from the Mica schists and Gneissic rock. The land is rolling and little of it steeply hilly because well nigh the entire township is occupied by upland divides from which originate a number of the smaller streams which are either the sources of larger streams, such as the west branch of Chester Creek, or are tributaries of larger streams such as Harvey's Run and Beaver Creek are of the Brandywine. Some of the land near the sources and on the divides and along these streams is low and spouty and needs underdraining, as is the case in the vicinity of Chadd's Ford and along the small streams northeast of this place and along Harvey's Run eastward. These spouty areas are limited, but when underdrained make among the richest farming land throughout this section. More feldspathic rock seems to enter into the formation of the soil throughout this township at such places as Brandywine summit, Painter's Cross Roads, and other places than any township previously discussed. Kaolin, a clayey formation,

derived from Feldspar, occurs along Beaver Creek in large quantities, and takes part in the formation of the soil with injurious effects; while where the undecomposed Feldspar occurs and the soils are of a red clayey type the land is fertile and adapted for raising the regular farm crops, especially the clovers when some lime is used. It is evident from what has been said in regard to the derivation of the soils of this township up to this time that a considerable area of clays occur adapted for raising corn, clovers, the hay and pasture grasses, such as blue grass and timothy. These soils are especially adapted for the dairy or livestock industry, because all the legumes that will thrive under prevailing climatic conditions find congenial soil environment throughout this and previously discussed township, wherever the clays, the rolling loams and the gravelly loams occur.

CONCORD TOWNSHIP

This township lies east of Birmingham and south of Thornbury, with its southwestern part bordering on the Delaware State line. The land is usually moderately rolling except along some of the streams, such as Chester Creek in the eastern part where it is steeply hilly and not well adapted to farming; but adapted for raising timber such as poplar and chestnut, both of which seem to thrive luxuriantly. The less steeply hilly is equally well adapted for growing timber, and could be profitably used for growing the improved chestnut, as well as the English walnut. In the southwestern part of the township a considerable area of what is recognized as a conglomerate soil, not heretofore referred to, occurs, composed of conglomerate sandstone and clay which makes a red Ferruginous or iron ore red soil of good fertility and adapted as the more clayey soils of this formation are for raising the dairy or livestock feeding crops, as well as the pasture grasses such as blue grass, and the hay grasses such as timothy. The Kaolin soil, referred to in the discussion of Birmingham township, occur west of the conglomerate and are similar to the soils referred to in that township.

In the eastern and southeastern part of the township, and extending through the central part to the western and northwestern corner, the soils are derived from the Feldspathic Mica schists and Gneissic rock, with moderately rolling land, except along some of the streams where steep inclines or in some instances precipitous, rocky outcrops occur. The soils are deep, with splendid water and fertility holding capacity, adapted for raising all the regular agricultural crops, but especially corn and the clovers, as has been previously indicated. Beginning in the vicinity of Concordville, where numerous exposures of the rock occur, and where the land is hilly, and extending northward and northeastward through the northern central part of the township, the soils are derived from the Syenitic rock. The

soils are deep loams or gravelly loams, with large water and fertility holding capacity, especially is this true throughout the northern section of the township.

ASHTON TOWNSHIP

This township lies east of Concord, Bethel and Upper Chichester townships, along the western bank of Chester Creek. The land is hilly, with numerous steep inclines, and precipitous rock exposures along Chester Creek, considerable areas too hilly and rocky for carrying on successful farming operations, and, therefore, the land should remain in forest or should be planted with the nut producing trees for which these hillside areas are as well adapted as for growing forests. The soils are derived in a limited area on Chester Heights from the conglomerate, referred to in Concord township, which here produces deep, clayey loams, and again gravelly loam, splendidly adapted for raising all the regular farming crops, but equally adapted for raising alfalfa, especially with the application of some lime. The underlying Feldspathic rock also takes part in the formation of the soil in the vicinity of the conglomerate producing gravels, mixed with a red clay and loams, making fertile land, with apparently limited water holding capacity, because of which crops are reduced during dry seasons. The remaining soils throughout this central part of the township in which Chester Heights is located, are derived from the Micaceous and Gneissic rock and are similar to the soils previously discussed, derived from the same rock exposures. The soils of the entire southern part of the township are derived from these rocks with a number of small areas of Serpentine and allied rock, with their usual baneful effects wherever they take part in its formation. Through the central and northern parts of the township, the soils are derived from the Syenitic rock and, with the exception that the land is more hilly, with a larger number of boulders than is normally the case, the soils are similar with similar adaptations and capacities.

MIDDLETOWN TOWNSHIP

This township lies east of Ashton and south of Thornbury and Edgemont townships, between Chester and Ridley creeks. The soils of the township are derived from the Serpentine, the Granite, the Mica, Gneissic and Syenite. A larger area of soils, derived from Serpentine and allied rock, exists in this township than all the areas of this formation of the remaining townships combined. The southern line of this area approximately parallels the Philadelphia and West Chester R. R. between Chester and Ridley creeks on the south and northward approximately along Ridley Creek to within a few miles of the northeastern corner of the township, and thence southwestward to Lenni.

The soils derived from this formation, referred to in Radnor and Newtown townships, are remanents of this same ridge and what was said there in regard to its baneful influence on forest trees, undergrowth and agricultural crops is true here, except that here the area is so much more extensive and the mitigating effects of the Mica schists in which this rock usually remains are so limited that the bad effects are more pronounced. The large percentage of magnesia contained in Serpentine and allied rock, and the absence of the elements which enter more largely into the composition of plants are likely the causes for the barrenness of these soils. The following analysis gives the composition of a specimen of Serpentine from Mineral Hill, west of Ridley Creek.

*Moisture expelled at 110°, ...	2.10
Loss in ignition, ...	12.78
Silicic acid, ...	44.18
Alumina, ...	traces
Ferrous oxide, ...	1.64
Magnesia, ...	39.37
	100.07

The best methods, if such exist, for improving the soil has not been determined, and whether it could be improved by any method is a question, but that the underlying rock from which the soils are derived determines their fertility or unproductiveness is not any longer a question.

Granite rock also occurs with this formation and to some extent improves the soil wherever it is sufficiently disintegrated to make the larger component of the soil.

The soils of the part of this township south of the Serpentine section are derived from the Gneissic and Schistose rocks, with a number of small remanents of Serpentine rock scattered throughout this section, all of which affect the productive capacity materially. On the divide between the two creeks, the land is rolling, with deep, easily farmed, early spring farming, loamy soil, with large water and fertility holding capacity, adapted for raising the regular farming crops. In the northwestern corner of the township the soils are derived from this same rock, together with remanents of Serpentine. The soils derived from the Syenites are confined to the northern part of the township, and are similar to those discussed under Edgmont township.

*Pa. 2nd Geological Survey, C5 Page 62,

UPPER PROVIDENCE TOWNSHIP

This township lies east of Middletown and south of Edgmont, between Ridley and Crum creeks. The soils of the township are derived from the conglomerates referred to in Concord township, the Syenitic which occurs only in the northern part of the township, with numerous exposures of the rock in the vicinity of Upper Providence where, in many instances, it is largely disintegrated and makes comparatively deep soils adapted for similar crops of similar soils previously discussed. The soils of all but the northern part of the township, and the conglomerates in the northern part of Media, the county seat of this county, are derived from the Mica schists and Gneissic rock. In the northern part of the township the Serpentine ridge, discussed under Middletown township, continues in a series of remanents, extending in a northeastern direction which affect the soils as do those previously discussed. The land along and in the vicinity of Ridley and Crum creeks is usually hilly, with frequent precipitous exposures of rock along these streams, while on the divide between streams the land is rolling, this is especially the case south of Media, with deep loamy, warm, early spring farming soils splendidly adapted for raising all the regular farming crops, especially corn and the legumes.

The conglomerate soils occur on this divide, extending from Media northward for some distance, with soils very similar to those of similar derivation previously discussed.

MARPLE TOWNSHIP

This township lies east of Upper Providence, and south of Newtown, with Crum Creek on the western, and Darby Creek on the eastern border. The soils of the township are derived, with the exception of small areas of Serpentine in the northern part, and some extended sections of conglomerate on the higher ground, entirely from the Micaceous and Gneissic and Feldspathic Micaceous Gneissic rock. The conglomerate, previously discussed, occupies the higher rolling sections, with similar soils as those derived from similar formations discussed in other townships.

HAVERFORD TOWNSHIP

This township lies east of Marple, south of Radnor, with the Montgomery county line for its eastern, and Darby Creek for its western boundary.

The soils are derived from the conglomerates and the Micaceous rock with some clays in the northeastern corner, likely derived from the underlying Feldspathic rock. The land is less hilly except along some sections of the streams, than in the townships previously discussed. There are few indications of Serpentine, which makes the land as a whole, more fertile. The soils are deeper generally, with larger water and fertility holding capacity.

PROVIDENCE TOWNSHIP

This township lies south of Upper Providence, between Ridley and Crum creeks. The soils of the township, except in the southern part, are derived from the Mica and Gneissic rock, and are deep, loamy, warm, early spring farming soils, with splendid water and fertility holding capacity, adapted for raising all the regular farming crops. The southern part of this township will be discussed in connection with the southern townships of the county.

BETHEL TOWNSHIP

This township lies south of Concord and west of Ashton, with the State of Delaware on the southern and southwestern boundary. The soils of this township, with the exception of a narrow strip along Green Creek, along the northern border, are derived from the Feldspathic Syenitic rock, of which the principle exposures occur along the streams and some of the woods with an occasional exposure in the fields. The land is moderately rolling, with soils which are comparatively deep with large fertility and fair water holding capacity adapted for raising all the regular farm crops. The soils of Micaceous, Gneissic, trap and Syenitic derivation on the higher rolling sections are among the best crop accommodating, warm, early spring farming lands of the State, with such a distributive water-holding capacity that, except under very abnormal conditions, they seldom become too wet or too dry when cultivation for surface mulch is practiced for crops to grow.

With such specially adapted agricultural capacities, these soils will lend themselves to the highest developed intensive farming with both soil improving and soil exhausting crops as will grow in the comparatively cold weather of the spring, the hot weather of the summer and the cool weather of the fall, making it possible for the farmer to take advantage of the entire growing season of the year.

THE NORTHERN AND CENTRAL TOWNSHIPS OF THE COUNTY

This county is thickly settled with many villages, larger towns and a city within its limits, as well as villages, larger towns and cities outside of its limits, but easily accessible, furnishing among the

best markets anywhere in the State for all that can be produced by the farmer and the market gardener. Large areas of the warm, early spring farming, sandy and gravelly loams, as well as the loams occurring on these rolling uplands, and those located on the southern and eastern slopes of the hillsides, with similar soils, are splendidly adapted for market gardening, and with the easily accessible large city, town and village market should be largely used for raising these crops, and where more of these crops are produced than the market will consume, canning factories, operated by the producers should be built in accessible places, and the surplus canned for winter consumption. The soils derived from the trap, Syenite and Granitic rocks are among the best fruit soils, being similar in derivation to the apple and peach soils of the South Mountain district, and will produce vigorous trees which will yield large crops of well developed, nicely colored, well flavored fruit. Such a formation of soils occurs at Glenn Mills, east and west of Cherry Station, in Thornbury township, and also in the northwestern corner of Radnor township, with numerous smaller areas in the remaining townships.

Besides these specially well adapted areas, the more stony, rocky and difficult to farm hillside sections, with soils derived from the Micaceous rock which do not wash readily, will produce large crops of well developed, well colored, nicely flavored fruit. These areas are more extensive than the specially adapted areas are and need more consideration, and the soils more care, but with this care the steeper hillsides can be made to produce larger returns than they are now doing with less loss of soil and fertility than by raising farm crops, and with the canning industry established for canning the surplus of fruit and market gardening products whenever a surplus of these crops is produced, and likely as large prices obtained in this way as by selling the fruit as it ripens. Furthermore, as previously stated, the special agricultural adaptations of these soils make it possible to develop a system of cropping by means of which both the soil improving and the soil exhausting crops can be made to interlock or follow each other so that the returns of the farm, either through the dairy or other livestock industry may be increased and the soil improved. A number of successions that would make this possible could be suggested, among which a very simple one is the following: Corn the land sown with crimson clover in July or August, the crimson clover plowed down the following spring, the land planted with soja beans or cow peas, these harvested and the land sown with red and alsike clover and timothy, or with alfalfa, and either timothy and clover or alfalfa harvested for hay for two seasons, and the sod plowed up for corn, followed with the same crops previously enumerated. These are among the best corn soils

in the State, and when care is exercised in the selection of seed, will produce and ripen as large and well developed ears of corn as can be produced anywhere in southeastern Pennsylvania, but when such care is not exercised, especially in the selection of stalks that will put their energy in the production of a large, well developed ear with long grains, an apparently inherent tendency develops an enormous stalk at the expense of an ear not comparable with the size of the stalk. This same tendency prevails throughout all southeastern Pennsylvania, but it seems to be intensified in this and parts of Chester county.

UPPER DARBY TOWNSHIP

This township lies south of Haverford and east of Springfield, with Philadelphia county on its eastern border. What has been said about the soils of the rolling lands in the townships previously discussed, their derivation, capacity and adaptation, is true of northern Upper Darby and nearly all of Springfield townships, especially their adaptations for raising crops for feeding the dairy herd. Much of this land is used for residential purposes, but wherever the land is unoccupied it should be farmed or used for raising truck crops to supply the market previously referred to. This land needs some lime occasionally to stimulate chemical action in the mineral combinations which occur in these soils. The following analyses of the various rocks, or rocks of similar composition which make up the mineral components of the soils throughout the townships previously discussed, may give some idea of what might occur by the action of caustic lime on these components.

	Syenitic Gneiss	Granitic Rock	Gneiss
	%	%	%
Loss by ignition, ...	0.83	0.44	1.21
Silicic acid, ...	57.51	63.44	35.81
Titanic acid, ...	2.01	.....	4.21
Phosphoric acid, ...	0.33	.....	.....
Alumina, ...	14.45	21.11	17.14
Ferric oxide, ...	5.54	.....	2.73
Ferrous oxide, ...	6.49	0.47	18.49
Manganous oxide, ...	0.57	.....	0.33
Magnesia, ...	4.47	0.26	9.79
Lime, ...	4.20	3.32	.....

Soda, ...	3.22	6.29	0.30
Potash, ...	0.21	4.42	9.46
Flourin, ...	.....	.....	0.79
	99.83	99.75	100.26
Less oxygen equivalent to flourin, ...			0.33
			99.33

TOWNSHIPS IN THE SOUTHERN SECTION

In southern Springfield, southern Upper Darby, Darby, Ridley, Chester, southern Upper Chichester and lower Chester, the soils are largely derived from gravel and clay deposits, and are gravelly or clayey in harmony with the source from which they are derived.

DARBY TOWNSHIP

This township lies south of Upper Darby, east of Springfield, with the Philadelphia county line for its eastern boundary. With the exception of the northern part of the township, the soils are well nigh entirely derived from the gravels and clays. The land is moderately and gently rolling with deep, and wherever the gravels prevail, warm, early spring farming soils, while where the clays predominate, the land is in some places wet and needs underdraining, but these areas are not large, and occur only along the streams and below their low escarpments, while above these escarpments on the rolling land, the soils become dry sufficiently early in the spring to begin farming operations so that these stronger soils will produce as large a preliminary growth until the warm growing, early summer weather comes, as those more early warm, early spring farming soils in which crops can be started considerably earlier, with this exception that while these soils are normally cooler in the hot summer season than the early farming soils, yet these early farming soils will normally produce larger yields of alfalfa, and of the cool weather, short season clovers, either fall or spring sown, than these clay soils will. These soils produce when well cultivated, (and they respond to good tillage admirably) as large or larger corn crops, than any soils anywhere in the state. The tendency, as before stated, to produce a large stalk at the sacrifice of a comparable large ear is more pronounced in these soils than in the loamy soils of the townships previously discussed, and, therefore, more care must be exercised in the selection of seed. These soils produce enormous crops of the sugar and other varieties of beets. These beets make a splendid succulent winter dairy feed which can be fed in place of silage.

RIDLEY TOWNSHIP

This township lies west of Darby and south of Springfield, with Darby Creek for its southern border. The soils of this township are formed from the gravels and clays, except a narrow section which extends along Darby Creek and makes quite a distinct escarpment south of which the soils are derived from alluvial deposits of the Delaware River, and are deep, and wherever they are sufficiently dry, they are among the richest soils in the State, containing sufficient moisture and fertility to produce a crop of the most succulent vegetables in the dryest seasons. Clay soils which are difficult to handle, and need underdraining, also occur in the southern part of this township, otherwise the soils are similar, with similar adaptations and capacities as those discussed in Darby township.

CHESTER TOWNSHIP

This township lies west of Ridley and south of Providence on the Delaware River. The gravels extend over nearly the whole of the southern part of this township with similar capacities and adaptations as similar soils previously discussed; while in the southern part of the township the soils are largely made up of clays and alluvium. Chester, the largest city of this county, is located in this township, and it together with the surrounding towns and villages, covers nearly the whole township so that there is not a large area of available farming land, and what might be available is largely in the hands of real estate agents.

UPPER CHICHESTER TOWNSHIP

This township lies west of Chester and Ashton townships on the Delaware state line. The soils of the northern part of this township are derived from the Syenitic rock and likely clays and gravels, while in the southern part they are derived from the gravels, and the clays, and are similar to those previously discussed

LOWER CHICHESTER TOWNSHIP

This township occupies the southwestern corner of the county, bordering on the Delaware River and the State of Delaware. The alluvial soils cover the southern part of this township, and are similar to those previously discussed, while the remainder of the township is covered with gravels and clays. The soils of the gently rolling lands, derived from the clays and gravels of the southern part of this county have large crop accommodating capacities, with so large and distributive a water and so tenacious a fertility holding capacity that crops seldom suffer from too large or too small a water supply or a very insufficient supply of fertility, wherever the soil improving

crops are raised in connection with the soil exhausting crops, and where stable manure is applied in the right way and where lime is used when needed. Every available area of this county should be used for raising the crops for which it is adapted, by the application of the most highly developed methods of intensive forestry, intensive fruit raising, intensive dairying, intensive livestock raising, intensive market gardening to supply the large markets for all these crops in the immediate vicinity.

CHESTER COUNTY

Chester county was the first of the three original counties established by William Penn within a few months after his arrival in 1682, and was named Chester, in remembrance of a city in England, by his friend and companion Pearson. That part of Chester county, which is now Delaware county, was taken up earlier by the Swedes and agricultural operations were begun as early as 1645 along the western shore of the Delaware River, extending as far and farther than the prsent limits of Chester county and, therefore, some of this land has been farmed equally as long as Delaware county, or a period of about 275 years, which, today, is as productive as at any time. It contains 497,280 acres, of which 423,827 acres is land in farms, and of which 351,525 acres is improved farm land. In 1909, 49,865 acres were planted with corn, yielding 1,881,653 bushels; 22,253 acres were sown with oats, yielding 928,090 bushels; 74 acres were sown wth buckwheat, yielding 1,071 bushels; 1,514 acres were sown with rye, yielding 26,650 bushels; 10,737 acres were planted with potatoes, yielding 735,153 bushels; 490 acres were planted with tobacco, yielding 552,193 pounds; 90,552 acres were sown with all forage crops, yielding 142,335 tons of the various kinds of hay. At this time Chester county had a population of 109,213 to feed, 65,113 cattle, 18,965 horses, 1,079 mules, 21,406 swine and 5,325 sheep.

Chester county lies south of Berks and Montgomery, west of Montgomery and Delaware counties and the State of Delaware, east of Lancaster and Berks with the Maryland line for its southern boundary. The geological formations, which make the basis of its soils, are composed of Azoic slates, small areas of Serpentine, Potsdam sandstone, Hydro Mica shists, Silurio Cambrian limestone, trap rock and the Mesozoic sandstone and shale.

WEST NOTTINGHAM TOWNSHIP

This township occupies the southwestern corner of the county having the Maryland line for the southern boundary and the Octorora Creek forming the boundary between it and Lancaster county. The soils of this township have for their basis the Hydro-mica and Mica Gneiss and the Serpentine rock. The Micaceous rock forms the soil in the northern part of the township and along the Octorora Creek in this section. The land is hilly with some steep slopes especially along the streams. The rock disintegrates readily, washes easily so that many of the hillsides have been washed down to the underlying rock, since the forests have been cut away making them rugged and steep, difficult to farm, so as to make the farming of these hills not a very lucrative occupation. As already stated these rock yield readily to the agencies of disintegration, and where the land is rolling, the soils are deep and can be made productive, by the application of stable manure, plowing down heavy sods especially clovers and by frequent but light applications of lime. These soils are chemically inactive, but they have such a hunger for organic matter that when the supply is kept up constantly, with small additions of lime, they become chemically active and produce, considering their origin, splendid crops of clovers, corn, wheat, rye and buckwheat, and with careful management will produce timothy hay.

The soils of the southern part of the township are derived from the Serpentine rock, and along the base and on top of the ridges formed by this rock where disintegration has proceeded sufficiently far to form clayey soil, these can be made to produce the regular farm crops, especially timothy. By the application of stable manure, lime and phosphoric acid, while the rock type is too poor and too difficult to handle to raise any agricultural crops. The land is known as the "Barrens," only the scrubby types of trees thrive.

EAST NOTTINGHAM TOWNSHIP

This township lies east of West Nottingham township, on the Maryland line. The southern part of this township, with the exception of a small area, has soils formed of the Serpentine rock similar to those discussed in the previous township. The Azoic slates or the Micaceous shist slates form these soils not formed from the Serpentine. These will be discussed later. The soils of the central and northern sections of Nottingham are formed largely of the more easily disintegrated Hydro-mica and Gneiss rocks which produced a loamy soil well adapted to the raising of all the regular agricultural crops. The land formed of these rocks is, in many instances, gently and moderately rolling. In the vicinity of Oxford in the northern part of this township is one of the nicely rolling sections, with soils

adapted to the raising of all agricultural crops. Alfalfa thrives in this section and it seems could be made one of the regular farm crops.

This land is easily farmed and responds readily to good agricul tural treatment. West of Oxford, partly in this and in West Notting ham and partly in Oxford township, the more hilly and less fertile soils of this formation ocur. Along the west branch of Elk Creek and along Elk Creek similar hilly and less fertile soils occur with adaptations such as were discussed in connection with West Nottingham township. Lower Oxford, lying directly north of East and West Nottingham on the Lancaster county line has soils derived from the same geological formations. The more easily disintegrated as previously stated forming the gently and moderately rolling land between the two branches of Elk Creek and west of the west branch along Limestone Road which traverses the western central section. West of this road along the Octorora Creek the land is more hilly with soils formed of the less easily disintegrated Mica shists containing intrusive veins of quartz which, when the rock disintegrates, remains on the soil and makes stony and sandy sections of little value for raising agricultural crops but adapted to growing chestnut, rock oak and black oak forests which has been and should now be the crops raised on these soils. The valleys between these hills have soils derived from the more easily disintegrated rock and with the soil washed down from the hills and hillsides are adapted, some even to intensive farming.

In the central part of the township is a considerable area of soil formed of the Mica shist and the Gneissic rock with similar adaptations. Upper Oxford lies directly north of Lower Oxford on the Lancaster county line. The soils of this township are derived from the same underlying rock as lower Oxford. The area of the rougher and more hilly land is larger than in Lower Oxford and farming is attended with more difficulties and the returns are not as large. The valleys and the rolling land formed of the more easily disintegrated strata are equally as fertile as those of Lower Oxford and adapted for raising the same crops.

WEST FALLOWFIELD TOWNSHIP

This township lies north of Upper Oxford, also along the Lancaster county line. The township, like Upper Oxford, has a considerable area of hilly and stony land, but a larger acreage of rolling land with some meadow land along the streams. This township joins the Limestone Valley on the north and is the northermost township of this formation along the Lancaster county line. As already indicated, these soils have a wonderful hunger for organic matter, and with that hunger only partially satisfied, they will produce, approximately, twice as large crops as they now do. With climatic condi-

tions and soil adaptations as they exist, it seems that the cow pea could be made the agency to furnish a high type of organic matter to give these soils the stimulus for larger production. Rye will usually yield fair returns on the poorer of the agricultural soils of this section, while oats usually yields poor returns except under abnormal climatic conditions, therefore, it seems that a rotation, in which rye should occupy the place of the oats, would be advantageous at least with the possibility of making the cow pea after the rye the agency of getting the much needed organic matter. To do this, sow the rye into the corn stubble after thorough preparation. After harvesting the rye, disk the ground and sow cow peas. Allow these to grow until the beginning of September, plow under or if not too rough and the soil is sandy and loose cut up with the disk and sow with rye or wheat the latter part of September and follow with clover and timothy upon which the manure should be applied, and this land planted with corn, after one or not more than two years of grass.

ELK TOWNSHIP

This township lies east of East Nottingham on the Maryland line. The soil in the western part of this township are largely formed of the Serpentine rock and are similar in structure and adaptibility to the soils of the same origin described in East and West Nottingham townships. The soil of the central and eastern part of the township is derived of the Gneissic rock and is hilly, washes rather easily and does not retain fertility very well. This land can be cultivated early and could be used for early trucking crops. After these are removed, a crop of cowpeas or soja beans could be raised for seed and the land sown with rye and hairy vetch and these plowed down and trucking crops again planted. In this way this land could be profitably farmed.

In the central part of the township is some moderately rolling land adapted to regular farm crop raising, with soils formed of the Hydro Mica rock.

NEW LONDON TOWNSHIP

New London township lies north of Elk and in the southern part has soils derived from similar underlying rock with similar adaptations as those in Elk township. In the vicinity of New London and thence northward to the township line and northeastward along the state road the land is some moderately rolling and some quite hilly formed of the Hydro-mica shists and the Gneissic rock. These soils are dark, red or light slate lands in harmony with the underlying rock. The dark and the red rock usually form the more fertile soils. Whether this is due entirely to the physical condition produced by the disintegration of the various types of rock or because of their

chemical composition, is not known, but that the darker colored rock disintegrates more perfectly and forms a deeper, more easily cultivated and productive soil is evident everywhere, and likely due to a more perfect physical condition. Penn township, lying directly north of New London, has the same types of soils as New London with similar adaptations, except the northwestern corner where the soil is formed of the Gneiss and has the adaptations of these soils which will be more fully discussed later.

LONDONDERRY TOWNSHIP

Londonderry township lies north of Penn. The soil formation of Penn continue northward through the central part of this township and are hilly with some rolling sections of a superior soil. In the western part of the township the soils are formed of the Gneissic rock, are more fertile in sections and should be farmed as already indicated. The same formation extends northward through Western Highland township, which lies directly north of western Londonderry. The upland in this western section are moderately rolling, while along the streams are some quite steep and hilly formations. Along the northern border this township is hilly with rough and stony soils not adapted to farming, but splendidly adapted to growing chestnut, rock oak and black oak timber for which much of it should be used. The same soil formation, the Micaceous shists continues along Buck Run with hilly land much of which is covered with chestnut and oak sprouting and which, if cared for as it should be, will within a generation yield paying returns from this source. Forest growing should be encouraged here because in this soil, chestnut and oak will attain a growth within forty years that will yield such returns that forty years of farming these soils will normally not do.

EAST FALLOWFIELD TOWNSHIP

East Fallowfield township lies east of Highland and, like Highland, along the limestone formation of the Chester Valley. The land is as hilly as eastern Highland with some rolling upland formations in the central part of the township adapted to farming and comparatively easily farmed and productive. Some of the hills have become more gently sloping, and the valleys have widened and some meadow land has been formed both from alluvial deposits and from the gradual disintegration of the hillside rock and the lowering of these. These lower hillside and valley soils make the best pasturing land in this county; but should not be used for this purpose because, by both underdrainage and deep tillage, these soils can be farmed and used for producing silage crops and in this way made to yield three times as much forage as they do by pasturing, which with the uplands better adapted to raising grain than large quantities of roughage,

would make a splendid combination for the dairyman of this section. Northern West Bradford township lying east of East Fallowfield has the same soil formation, also northern East Bradford, southern West Whiteland, northern West Goshen and East Goshen, southern East Whiteland.

The land throughout this entire section is hilly and some of it not adapted to farming but, as already stated, the more hilly section is splendidly adapted to growing the types of timber referred to. East Goshen, eastern West Whiteland are not as hilly as the other townships, especially is this true in the vicinity south of Frazer toward West Chester. Above the hills which skirt the Chester Valley the land is of a hilly, rolling formation with some beautiful stretches of easily farmed and productive soils. Further eastward, this Hydro Mica shist formation narrows until, at the Montgomery county line it is not two miles wide; whereas, along the Lancaster county line it is, approximately, fifteen miles in width. Throughout this formation are some beautifully rolling sections with limy soils adapted to intensive farming of the best developed type. South of the Hydro mica formation, the Gneissic rock makes the basis of the soil.

FRANKLIN AND LONDON BRITAIN TOWNSHIPS

Franklin and London Britain townships occupy the southwestern corner of this formation in this county, the former lying east of New London township on the Maryland line and the latter east of the former with the Maryland line for its southern boundary and the Delaware State line for its southern and eastern boundary. In southwestern Franklin township, the Serpentine rock forms the basis of the soil and is similar in structure and adaptation to the same formation in Elk township west of it and already described. Eastern Franklin is more rolling, with soils derived of the Gneissic formation which are more fertile and adapted for raising the regular agricultural crops; but it seems the more hilly lands would bring larger returns if a rotation such as has been previously suggested would be adopted.

London Britain township has similarly derived soils with similar adaptation. Along the White Clay's Creek are some alluvial soils derived from alluvial deposits brought down to the streams and from the hills by washing, which are adapted to intensive farming, especially it seems should such soils in this section be devoted to intensive dairy farming. Near the confluence of Clay's Creek and Broad Run, the Cambrian limestone comes to the surface and makes its influence felt in the formation of the soil; while in the same vicinity the Potsdam sandstone forms a small section of rough and stony soil adapted to raising apples and peaches and other stone fruit in better paying returns than regular agricultural crops.

LONDONGROVE TOWNSHIP

Londongrove township lies north of Franklin township and east of Penn and Londonderry. In the vicinity of Westgrove the Cambrian limestone crops out in a number of places and enters the formation of the soil, making this one of the most fertile sections of the county with soils derived from the disintegration of the combined limestone and Gneissic formation which make among the most productive soils in the State, adapted to the raising of all agricultural crops especially corn, of which it produces big yields of splendid quality and for intensive farming of a high order. In the hills in this vicinity the Potsdam sandstone combines with the Gneissic rock in the formation of the soil making fruit soils of the highest type. Some of this land is hilly especially where the Potsdam sand predominates, but not too hilly for successful farming, but especially not for fruit raising. The southern part of the township has soils similar to those of Franklin township. The northern part of this township lies entirely within the Gneissic formation with soils derived from these rock not as steeply rolling as the land south of Westgrove. The limestone already referred to extends eastward through the central part of the township in a narrow strip to the vicinity of Kennett Square and Toughkenamon, but does not produce as salient effects in the formation of the soil, as in the vicinity of Westgrove, because the outcrop is not as extensive.

WEST MARLBORO TOWNSHIP

Southern West Marlboro has soils derived from the same underlying rock as northern Londongrove, with similar adaptations. The land is hilly, with hillsides that have been rounded and can be farmed.

In the vicinity of Doe Run, in the northwestern part of the township, is an area, into the formation of the soils of which the limestone has entered and made soils very similar to those in the vicinity of Westgrove except that the land is more gently rolling and not as well drained, but equally productive and adapted to the same kind of farming.

Central West Marlboro is generally more rolling than the other section of the township and, therefore, washes less, is more easily farmed, with somewhat deeper soils which are more productive than the more hilly land of the same Gneissic formation.

New Garden, Kennett, East Marlboro, south Newlin, Pocopson, East Bradford, Pennsburg, Birmingham, west Thornbury, West Goshen, southern East Goshen, Willistown, and Easttown townships all lie in the same formation, the Gneissic, as central West Marlboro with such exceptions as will be referred to in the following discussion.

NEW GARDEN TOWNSHIP

The same formation of Potsdam sandstone and limestone that occurs in eastern London Britain township occurs in southern New Garden with soils of similar adaptation. Northward from this formation the soil is derived of the Gneissic rock and the land is moderately rolling, the soil deep with large water and fertility capacity and with good farming, continuously productive. From Toughkenamon eastward where, likely, the Potsdam sandstone forms sandy ridges are soils which are not as fertile but will produce good crops of rye and can usually be used for early truck crops or they are well adapted for raising peaches, apples and the stone fruits, as well as the small fruits.

KENNETT TOWNSHIP

Kennett township lies east of New Garden on the Delaware State line. This township—with the exception of the northwestern corner, northwestward of Kennett Square where the same sandy formation, the Potsdam, together with some limy strata occurring also in New Garden, causes a hilly country adapted to fruit growing—lies in the moderately rolling Gneissic deep, easily farmed soil of large water holding capacity with with care does not easily wash and resists drought well and if it would contain such quantities of organic matter as it can readily be made contain the summer shower would during the greater part of the season be of secondary consideration.

EAST MARLBORO TOWNSHIP

This township lies north of Kennett and New Garden and east of West Marlboro. The soils of the township are formed of the Gneissic rock except in the south central part where the sandy formation of the northwestern corner of Kennett township forms sandy ridges not as fertile as the surrounding rolling soil but, as already stated, adapted to early market crops and for raising peaches and small fruit. In the northeastern corner of the township the Serpentine rock crops out and makes several small sections of poor soil. The limestone, referred to as occurring in Londongrove township, occasionally occurs through the central part of this township and the central part of New Garden and in the vicinity of Kennett Square, but it takes small part in the formation of the soil and, therefore, its effects are only noticeable in a limited way.

NEWLIN TOWNSHIP

Newlin township lies north of East Marlboro and west of East Fallowfield. The southern part of this township is in the Gneissic formation of soils with more hilly land than the township to the south of it. The central and northern parts of the township are

hilly, with more sandy soils, except along the West Branch of the Brandywine Creek where the hills, in many places, have been rounded and lowered and the valley of the stream broadened and a fertile soil of deluvial, and to a certain extent alluvial formations have been produced, of splendid fertility adapted to intensive dairying.

PENNSBURG TOWNSHIP

Pennsburg township lies east of Kennett and East Marlboro. The soil of the northern part of this and Pocopson township, which lies directly north of it, are formed of the Gneissic, with some intermixture of Mica Gneissic rock, and are moderately rolling with some sections of gently rolling land of splendid fertility, adapted to intensive dairy farming of the highest type. The south central and southern parts of the township have some of the sandy uplands already referred to. The limy formations referred to as occurring at Kennett Square shows in a limited way through this hilly section but does not take part in the formation of the soil.

EAST BRADFORD COUNTY

This township lies north of Pocopson and east of West Bradford. Between Plum Run and the east branch of the Brandywine is a divide of uplands with sandy ridges and some steep slopes with soils that are well adapted for early truck crops as well as for raising fruit, while the valleys and lower hillsides are adapted to regular farm crops.

Along the Brandywine are some soils similar in derivation and adaptation to those referred to in Newlin township. West of the Brandywine the land is more rolling, though hilly, with fewer sandy ridges.

In southern and central East and West Goshen the land is generally, moderately rolling with deep easily farmed soils, derived of the more easily disintegrated Gneissic rock and except at Rocky Hill, having large water-holding capacity and enduring fertility. These soils will produce large yields of corn, wheat, clover, potatoes, and the lower lands large yields of hay. It seems, with the natural fertility of this land, that with the dairy a permanent agricultural operation could be established that would yield enticing returns. East of West Chester, the county-seat of this county, which is located in this township, is a section of low land of splendid fertility, but rather too wet for farming crops to thrive, but which with underdrainage can be made the most productive land in this vicinity.

BIRMINGHAM TOWNSHIP

Birmingham township lies east of the Brandywine and has the Delaware county line for its southern boundary. Along the Brandywine are soils of similar derivation and adaptation to those referred to in Newlin and East Bradford townships; otherwise the land is similar in derivation and adaptation to that of the townships with soils of Gneissic origin above referred to, except that it is more steeply rolling and more stony in some sections.

The soils of Thornbury, Westtown, Willistown and Easttown townships are derived from the underlying Gneissic rock and are very similar in formation and adaptation to the townships already discussed, except that the land is more steeply hilly in Thornbury and that at such places as where the east and west branches of Chester Creek unite a considerable area of alluvial soil occurs adapted to intensive dairy farming, while the more hilly land is not so well adapted for such an operation.

This same alluvial soil extends into Westtown township along the east branch of Chester creek. In western and southern Willistown the Serpentine rock crops out and forms some poor and rough land while along the western boundary the Granitic rock intermingles with the Gneissic and forms a rougher though a more fertile soil especially adapted to apple and peach growing. Through the central part of this township the rolling Gneissic soils prevail while in the northern part of the township the Serpentine rock forms the basis of a considerable section of clay soils of fair quality similar to those discussed in west Nottingham township.

In Easttown township the hilly land continues with soils formed of the Gneissic and in the central part of the township of an intermixture of Granitic rock making in many places a rough but productive soil adapted especially to fruit raising. North of the Chester or Limestone valley the greater part of the soils of the following townships are formed of the Gneissic rock, beginning in the eastern part of the county: Charlestown, West Pikeland, southern East Pikeland, West Vincent, the northern part of Uwchland, Upper Uwchland, East Nantmeal, southern Warwick, West Nantmeal, Wallace, East and West Brandywine, northern Valley, northern Sadsbury, northern West Sadsbury, West Caln and Honeybrook.

Charlestown township lies directly north of the Chester Valley and is the terminus of the Gneissic formation in this part of Chester county. The land is hilly with ridges of Potsdam sandstone especially along the Limestone Valley, with stony soils on the ridges, not well adapted to grow agricultural crops but adapted to growing forest trees; the less stony and rocky sections of which are splendidly adapted for raising apples and peaches. The eastern point of this township and the northern part of Tredyffrin and the southern corner

of Schuylkill townships have similar soil formations and similar adaptations. The central part though not as rough, is however steeply hilly along the streams with some small sections of rolling uplands with comparative smooth soils of good fertility.

Southern East Pikeland and West Pikeland, both lying directly west of Charlestown, have the sandy ridges already referred to as well as the steeply rolling formation with soils similar to those already described in such townships as Elk and Newlin, south of the Chester Valley.

The valleys in this part of the county are broader and therefore contain more of the alluvial soils, if they can be so termed, than in the southern part of the county, otherwise the formation and adaptation is practically the same.

WEST VINCENT TOWNSHIP

Northeastern West Vincent township is moderately rolling, while along Birch Run, in the central part of the township, the sandy ridges occur with steeply hilly land. West of this stream the land is hilly, with some rough land along the northern part of the township not adapted to farm crops but a considerable part of which would be well adapted for apples and peaches. In the southern part of the township, along the Conestoga Pike, near the southeast corner of the township, the Potsdam sandstone forms a rough, stony and hilly section, much of it available for fruit growing.

THE UWCHLAND TOWNSHIPS

Upper Uwchland and Uwchland in the eastern sections contain less steeply rolling lands than the western part which is steeply rolling with the sandy ridges already referred to and with soils that in many places are rather difficult to farm and not so productive.

In southern Uwchland the soil is derived from the Potsdam sandstone which here is less hilly and not so stony and which, where the sandstone and the Gneissic rock come together and intermingling of the two formations produces a more fertile soil. In the western part of the township, along the East Branch of the Brandywine where the Feldspathic formation of sandstone occurs, is some rough and hilly land, on which the forest growth is so immense that the limiting factor in development seems not to be a matter of soil fertility but of sunlight. This must be fruit soil.

EAST BRANDYWINE TOWNSHIP

East Brandywine townships, west of East Brandywine Creek, has soils in the eastern part of similar derivation and adaptation. Much of it is hilly, stony and difficult to farm, but it will produce trees. Western East Brandywine lies within the Gneissic formation, has

few sandy ridges and more moderately rolling land with deeper soils derived from the more easily disintegrated rock of this formation. Eastern West Brandywine township has soils of similar derivation and topography, except along Beaver Creek, where some alluvial soils occur, adapted for raising the hay grasses. Beginning in the southern part of the township and extending northward approximately through the central part a more sandy rock forms the soil, which is less fertile, more liable to washing and on account of its porosity loses its fertility readily unless so farmed that it will contain large root systems of growing plants and a large quantity of organic matter which will hold the fertility in organic combination and which the roots of the growing plants will take up as it is made available, and in this way be retained in the plants and not washed out.

In the north central part of this township, east of Brandywine Manor is a strip of soil formed of the Potsdam sandy formation which is less stony, with a soil that is quite productive. Along the West Branch of the Brandywine is some low land in this township which needs drainage.

Eastern Caln, northern Sadsbury and central West Sadsbury are hilly, with soils formed of the more sandy Gneissic rock with adaptations such as have already been discussed. Northern West Sadsbury and all of West Caln lies within the Potsdam formation known as Barren Hill, with stony soils, much of it difficult to farm and not extra well adapted for raising agricultural crops but apparently well adapted for raising peaches and apples for which it seems it should be used. Honeybrook and West Nantmeal, except the northern parts of these two townships and northern Wallace, all lie within the moderately rolling section of the Gneissic formation with deep easily farmed soils, with splendid water and fertility holding capacity, making this one of the best farming sections of the country.

In the northern parts of Honeybrook, West Nantmeal and Warwick the Potsdam sandstone and the Granitic rock make the basis of the soils. This land is stony and much of it is therefore difficult to farm, but much of it can be farmed and is especially adapted for fruit growing, and if planted with peaches, apples and plums and smaller fruits would yield returns larger than the best farming soils in the county.

THE CHESTER OR LIMESTONE VALLEY

This valley occupies approximately the central part of the county and forms parts of the following townships: Beginning at the western border on the Lancaster county line, southern West Sadsbury, southern Sadsbury and Valley, southern central Caln, southern East Brandywine, nearly the whole of East Caln, northern central

West Whiteland, nearly the whole of East Whiteland and Tredyffrin, which joins the Montgomery county line on the eastern extremity of the county. The soils of the greater part of this valley are derived from the underlying Cambrian limestone strata and the Micaceous limestone which occurs between the strata or through the strata of the purer limestone, this latter formation occurs mostly along the sides of the valley, except in a few places where the valley is narrow, as at Coatesville where some of these strata occur in the central part.

The soils formed of this limestone are the most fertile general farm crop soils in the county. They are usually deep, have a large water holding capacity, respond splendidly to good agricultural treatment and will endure agricultural abuse longer and still produce crops than any soils in the county. In West Sadsbury and Sadsbury townships the valley is narrow and the limestone soil is hemmed in by comparatively high ridges, on the north by the Potsdam and Feldspathic sandstone and on the south by the Hydro-mica sandy formation both of which have effected the soil in not a beneficial way both physically and also in its fertility. West of Atglen in the central part of the valley is a ridge of the sandy Gneissic and Potsdam formation with the characteristic of the hills on the sides of the valleys. Valley and Caln townships are similar to the Sadsburys. In East Brandywine township the valley widens and the land is more moderately rolling with deeper and more fertile soils, less effected by the formations of the ridges along the sides of the valley. Along the Brandywine, which crosses the valley near Downingtown in this township, is a considerable section of alluvial soil of splendid fertility adapted to intensive farming of the highest type. The same conditions prevail in West Whiteland township. In East Whiteland the valley attains its greatest width in this county, forming a beautiful stretch of fertile land with intruding ridges of sandstone and low land along the streams, some of which needs drainage but the greater part is well drained and is adapted to the highest order of intensive farming. In Tredyffrin the valley narrows somewhat but maintains its splendid fertility. This valley is the natural milk dairy section of this county, every acre of which could and should be made to produce two and three times as large crops as they now produce. A series of crops such as corn, followed with crimson clover or rye and hairy vetch for a winter cover crop, followed with Canada field peas and oats, these followed with alfalfa and then corn, would, it seems, be a succession that would bring results.

The following have soils formed largely from the Mesozoic red and grey shale and sandstone: Schuylkill, northern East Pikeland, East Vincent, East Coventry, South Coventry, and North Coventry.

SCHUYLKILL TOWNSHIP

This township lies northeast of Charlestown along the Schuylkill River. In the southeastern part of the township the land is moderately rolling, some of it gently rolling, especially along the Schuylkill River. The soils in such places are deeper and more fertile with a much greater water holding capacity than is usual for soils derived from the rocks of this formation. At some distance from the river where the land is more rolling, the underlying rock frequently come close to the surface, especially along ridges and makes soils that wash readily, have small water holding capacity, and unless sufficient and not too much rain falls, at short intervals, crops are a positive failure. Where disintegration has proceeded sufficiently to make a soil of some depth, the land produces well all the regular farm crops, especially timothy hay. Northwestward from this section the soil is derived from the underlying brown and grey Mesozoic sandstone and shale. This rock disintegrates more readily than the red shale and, therefore, makes a deeper soil, with a larger water holding capacity and greater fertility. This soil is adapted to wheat raising. The clovers thrive well in it, especially alfalfa will, if the land is thoroughly prepared before sowing, yield larger returns than any crop that this land will produce. This is the writer's own experience. At Phoenixville the land is hilly, especially northeastward where the river curves around the ridge of sand rock in which the trap seems to crop out. This ridge extends westward through the township making some stony and in some places hilly land not very productive and in many places difficult to farm. It is not a good type of fruit land unless the trap rock which frequently underlies this special formation comes to the surface and enters into the structure of the soil. Where the Mesozoic and the Gneissic rock join in the formation of the soil, the land is more fertile than where the Mesozoic alone forms the basis. The soil in the vicinity of Kimberton, in East Pikeland township, is derived from both formations and in fertility is well nigh equal to the best limestone soils of the Chester Valley. This type of soil extends along the border where both formations come together and is among the best adapted for all crop soils, anywhere; on much of it the cereal grains, the hay grasses, clovers, potatoes, truck crops and fruits yield splendid returns.

Dairying in many places throughout this section is the principle farming industry. Northward from Kimberton, in East Pikeland township, the land is rolling, with sandy ridges, with thin soils and in less elevated sections with deep soils, such as has already been referred to. The hilly, sandy formation discussed in Schuylkill township widens in this township and becomes more prominent, with soils similar to those of Schuylkill township.

EAST VINCENT, EAST COVENTRY AND WARWICK TOWNSHIPS

East Vincent township lies northwest of Pikeland and north of West Vincent. In the southern part of the township the soils are derived from the red shale and sandstone, where the sand predominates are ridges with thin soils, while where the shale prevails the soils are deep and fairly fertile. Through the central part of the township the soil is derived from the gray shale, already referred to, and is deeper, with good moisture and fertility holding capacity, easily farmed and adapted to raising the cereal grains, the clovers, potatoes and on the more gently rolling, the hay grasses. East Coventry lies north and northwest of East Vincent. The soils of this township are derived largely from the red shale and sandstone of the Mesozoic strata with such adaptations as already referred to and with similar topography. North Coventry lies northwest of East Coventry. The land along the Schuylkill River is gently rolling and fertile, well adapted to raising the hay grasses, especially timothy which yields large crops. The soil away from the river at such places as Cedarville is largely derived from the disintegrated red shale and sandstone, with ridges and thin soils, where the sandy formation prevails and deeper soils where the shales are in the ascendency. In this section more advanced farming has been done than in any part of the county, on the red shale and sandstone land. In the southern and southwestern part of the township, the land is hilly with soils derived from the sandstone of the Mesozoic formation, which do not yield readily to the agencies of disintegration which therefore make stony and rough land not well adapted to farming but adapted to growing forest trees, for which much of it should be used. South Coventry township lies south of North Coventry and west of East Coventry. This township contains a large area of the rough and stony land already referred to, with similar adaptations. In the southern portion along French Creek are some alluvial soils of good productive capacity. In the southeastern corner, the rolling land of East Vincent still exists. Warwick township lies west of North and South Coventry, on the Berks county line. In this township the Potsdam sandstone, the Granitic, the Gneissic and the Mesozoic sandstone and shale all take part in the formation of the soil. It means that much of the land is hilly, rocky, stony and rough, difficult to farm, with in many places poor returns for the effort. But where disintegration has advanced sufficiently to make gravelly soils of these rock, the land produces well, such crops as rye, in some places wheat but especially the clovers. Potatoes yield splendid returns. But wherever the upland is sufficiently clear of rocks and the soil deep enough so that trees can be planted and cultivated and the hills not too steep, so that the fruit can be removed and marketed, wherever these conditions prevail this land should

be planted with apples, peaches, plums, pears, and small fruit of all kinds that will thrive under the prevailing conditions, because if existing conditions are any indication this township can be made to yield returns in fruit that the richest agricultural township will have difficulty to equal in the dairy and in the regular farm crops.

LANCASTER COUNTY

The rapid increase of the settlements in Pennsylvania made it necessary to form another county, accordingly the Assembly and Council established the new county of Lancaster, May 10, 1729, and it owes its name to John Wright, who was a native of Lancanshire, England. The beginning of agricultural operations in this county date from about 1696 to 1700. A number of farms in this county, the soils of which have been farmed since 1710, are still owned and in the name of the descendants of the original settlers.

It contains 602,240 acres, of which 550,499 acres is in farm land, of which 472,795 acres is in improved farm land. 80,825 acres were planted in corn yielding, in 1909, 3,287,787 bushels; 20,093 acres were sown in oats, yielding 622,401 bushels; 115,568 acres were sown in wheat, yielding 2,532,406 bushels; 33 acres were sown in buckwheat, yielding 541 bushels; 3,583 were sown in rye, yielding 62,879 bushels; 12,654 were planted with potatoes, yielding 831,723 bushels; 32,783 acres were planted with tobacco, yielding 36,892,869 lbs.; 109,843 acres were sown with all forage crops, yielding 144,139 tons of the various kinds of hay.

At this time Lancaster county had a population of 167,029 to feed, 66,516 cattle, 24,441 horses, 7,777 mules, 47,259 swine and 5,882 sheep.

The county lies south of Lebanon and Dauphin, east of York on the east side of the Susquehanna River and west of Chester and Berks on the Maryland State line. The soils of this, the richest agricultural county in the United States, a prestige it has maintained during the last century and a quarter, are derived from the Azoic rock, the Serpentine, the Chloritic, Schist series in the southern part, the Potsdam sandstone of minor consideration, the Silurio Cambrian limestone series from which the soils of the fertile Lancaster Valley are derived, the Mesozoic sandstone and shale from which the soils of the northern part of the county are derived, the trap dykes and drift materials along the river.

The following townships and parts of townsips in the northern part of the county have soils derived from the Mesozoic red shale and sandstone and the trap dykes; northern and central Conoy,

northern and central West Donegal, central and northern Mt. Joy, northern Rapho, northern Penn, northern Elizabeth, northern Clay, central and northern West Cocalico, all but the eastern part of East Cocalico and the whole of Brecknock, with small sections in the northeastern corner of Earl, northern East Earl, and all of norther Caernavon, will comparatively narrow sections in Ephrata and Warwick.

CONOY TOWNSHIP

Conoy township lies in the northwestern corner of Lancaster county, with the Susquehanna River for its western and the Conewago Creek, which form the line between Dauphin and Lancaster counties, for its northern boundary. The soils of the central part of this township are derived from the Mesozoic shale and sandstone and those of the northern part from the trap and Mesozoic combined. This trap dyke outcrops along the river about half mile below the mouth of the Conewago Creek, extends northeastward through the township with stony and hilly, though not steeply hilly land, with deep soils having comparatively large water and fertility holding capacity, the more moderately rolling and less stony types of these loamy soils, for such they are, adapted for raising the regular farm crops, wheat, corn, oats, rye, timothy, the clovers and potatoes, but especially adapted for raising a hard red high milling quality wheat and fairly large yields of a splendid quality of corn, while on the more steeply hilly and stony types apple and peach trees make a vigorous disease resisting growth that will produce large crops of well developed, nicely colored and flavored fruit.

Through the central part of the township the soils are derived from the Mesozoic red sandstone. The land is usually moderately rolling except where some rather high and steeply inclined ridges occur formed by the harder sandstone of these strata with thin soils with limited water and fertility holding capacity in which crop yields are materially reduced by only short seasons of dry weather.

On the more rounded hills and in the valleys of the moderately rolling section, the soils are deep with large water and fertility-holding capacity, adapted to raising the regular farm crops but especially adapted, the thinner as well as the deeper of these soils, for raising timothy hay and the usual hay grasses. Along the line of contact between the new red sandstone and the limestone and the limy slates the soils are usually deep with splendid water and fertility-holding capacity, and wherever the limy slates prevail, the soils contain sufficient lime for all crops, and only under abnormal conditions do these soils become acid which adapts them for the raising of such lime-loving plants as wheat, among the cereal grains, of which they produce large yields of a hard red variety; and alfalfa and red

clover among the legumes of which they also produce large yields. These soils are loamy with some gravel and are warm and can usually be cultivated earlier than the more clayey limestone soils to the south and are, therefore, better adapted for raising fall sown early summer ripening crops or for early spring sowing crops that will ripen in mid-summer. In short, these are among the best crop accommodating soils anywhere in the State.

WEST DONEGAL TOWNSHIP

This township lies east of Conoy on the Dauphin county line. The same granitic or trap dyke, discussed in Conoy township, traverses the northern part of this township with soils of similiar derivation, adaptation and capacity. The trap dyke and gray shale soils are more extensive than in Conoy, with a larger area of agricultural and fruit soils the more moderately rolling of which there is a considerable area, are among the best wheat and superior quality corn producing land in this section. Peach and apple trees make a vigorous disease-resisting wood growth which ripens well and produces large yields of well developed, highly colored, nicely flavored fruit.

The red sandstone formation, discussed in Conoy township, crosses West Donegal, but is only approximately half as wide with a narrow strip of gray shales through which the intrusive igneous rock which caused this change in the underlying rock sometimes breaks and takes part in the formation of the soil, changing the character and productive capacity, making it better and more productive when the soils becomes clayey.

MOUNT JOY TOWNSHIP

This township lies east of West Donegal on the Dauphin and Lebanon county lines. The same rock formations from which the soils of West Donegal township are derived cross this township in a northeastern direction. The trap dyke and gray shale formation which spreads over so large an area in West Donegal narrows until at the eastern extremity of this township, it is approximately only half as wide as in West Donegal. In the eastern extremity of this dyke the land is more steeply hilly and rougher, partaking of the character of the trap dyke in Lebanon county, where it is really mountainous.

As the trap dyke narrows, the red sandstone formation widens until in the eastern extremity of this township it is nearly twice as wide as in West Donegal township. Both formations and the soils derived therefrom are very similiar to the soils of West Donegal township, except that the soils derived from the trap and changed Meso-

zoic shales and sandstone are in the western part of the township more rolling and less rough with larger water and fertility-holding capacity, while the soils of the same formation in the eastern part are more hilly and rougher. The more extensive red sandstone land is in the eastern part less hilly than in the western with deeper soils and larger water-holding capacity, with similar adaptations to those previously discussed.

Along the line of contact between the red shale and the limestone the limy shales and what seems to be the Hydro-mica shist rock are so intimately associated that it is difficult to determine to which formation the strata really belong, but to whichever formation they may belong, the soils are more fertile than the soils derived from the red shale and sandstone or the Hydro-mica shists alone. These deep, loamy gravel soils with such water-holding capacity that will enable them in a dry season with a surface mulch of dry earth made by cultivation to, produce a crop of corn or tobacco, for the raising of both these crops these soils are admirably adapted. In the northern part of this township the Mesozoic conglomerate where disintegration has proceeded sufficiently far makes a gravelly soil fairly deep with fair water but rather poor fertility-holding capacity. In these soils, fertility should be applied in organic combination and growing plants, in so far as possible, should be in the soil at all times during the growing season, to take up and put into plant growth the fertility contained in the organic matter, such as manure and heavy sods plowed down, as it is made available. Apple and peach trees make a vigorous wood growth that ripens well and produces fair yields of a fairly well colored, well flavored fruit. On the higher elevations where disintegration has not proceeded sufficiently far, the soils are stony and in many places rough and should be allowed to grow forests.

RAPHO TOWNSHIP

This township lies east of Mount Joy on the Lebanon county line. The northern half of the township lies in the new red shale and sandstone area with soils of similiar derivation, capacities and adaptations as those discussed under Conoy and West Donegal townships, except that along the northern border on the southern slopes of the mountain across the county line in Lebanon county and discussed in connection with Londonderry township of that county, the soils are derived from the red sandstone of Mesozoic Age with a considerable area of steeply hilly land in many places rough and stony with thin soils not adapted to farming but adapted to growing forest. In the northeastern corner where the red sandstone and the shale rock, which comes to the surface in some places, mix in the formation of the soil the land is more moderately rolling and adapted

to raising agricultural crops. In the western part of the township, along the contact between the red shale and the limestone the formation, referred to in Mount Joy township, continues with soils similiar to those discussed in connection with that township with similiar capacities and adaptations. Between the limy soils and the hilly land is a considerable area of red shale land with high rounded ridges, with gravelly soils, with small water and fertility-holding capacity, while in the broad valleys the soils are deep with large water and fertility-holding capacity adapted for raising the regular farm crops, especially timothy.

PENN TOWNSHIP

Penn township lies east of Rapho on the Lebanon county line. In the northwestern corner of this township the same soils referred to in the northeastern corner of Rapho occur, making this the only section along this northern border that is not hilly. The Elizabeth hills, derived from the hard red sandstone previously discussed make the soils of the northern part of this township. The land is hilly and much of it difficult to farm and not adapted for raising farm crops except the less steeply hilly and less stony where the trap rock enters the formation of the soil. Fruit trees make a vigorous growth and ripen well, this growth and produce large yields of well-developed, well-colored and nicely flavored fruit. This applies to Rapho township also.

In the northeastern part of the township the sandstone belt widens, making a hilly country throughout this whole section, while at the foot of these hills the more easily disintegrated shaly strata make a more moderately rolling country, partaking in some of the less elevated sections of the character of the fertile limestone land to the south; but, as in Rapho township, so here are high ridges with thin stony soils that wash readily become dry so that crops will suffer for moisture and yields will be very materially reduced. These soils should be farmed in such a way that a large part of the vegetable matter they produce could be applied to the soil at once or soon afterward it is produced so as to retain moisture and keep up production.

ELIZABETH TOWNSHIP

Elizabeth township lies east of Penn on the Lebanon county line. The northern part of this township is hilly and rough with only small areas of farming and fruit land which are similiar to the soils of similar derivation and configurations as Penn township. The area of this rough and stony land is approximately twice as extensive as in Penn township.

CLAY TOWNSHIP

Clay township lies east of Elizabeth on the Lebanon county line. The northern part of this township, except along the northern border and in the northeastern corner, is hilly, with Black Oak Ridge forming a conspicuous feature along Middle Creek. The soils of the hilly section are of the same derivation with similiar capacities and adaptations as those of the townships previously discussed, while the northeastern corner is more moderately rolling with soils derived from the more easily disintegrated shaly strata of this formation.

WEST COCALICO TOWNSHIP

West Cocalico township occupies the northeastern corner of Lancaster county with the Lebanon county line for its northern and the Berks county line for its eastern boundary. The soils of the whole northern section of the township except an occasional outcrop of trap rock are derived from the sandy strata and the conglomerates of the new red formation and are similiar to those previously described in Mount Joy township.

Beginning with the northwestern corner with the more shaly strata referred to as occurring in the northeastern section of Clay township, a more moderately rolling valley with deeper soils having fair water-holding capacity derived from the shaly strata extends through the central part of this township to and beyond its eastern boundary. South of the more rolling part is another hilly section with soils derived from the sandy strata and conglomerates of the red shale with, in the rougher sections, thinner soils, while where the conglomerates have disintegrated the soils are deep and fertile in this southern as well as in the northern part and produce farm crops of superior quality.

EAST COCALICO TOWNSHIP

This township lies southeast of West Cocalico on the Berk's county line. The land in the northern part of this township is steeply hilly with soils derived from the conglomerate rock referred to in Mount Joy township. A considerable area is too rough for farming and not adapted for raising farm crops but adapted for raising fruit wherever the soil is sufficiently deep in the rougher sections, while in the more rolling parts the land is fertile and produces farm crops such as wheat, corn and oats of superior quality.

Trap exposures occur frequently throughout these townships which, together with the conglomerates, makes a very desirable fruit soil which produces a vigorous, well ripened wood growth that will yield large crops of well developed, rather well colored, fairly flavored fruit. Some fruit is being raised throughout this section.

BRECKNOCK TOWNSHIP

Brecknock township lies completely within the Mesozoic formation with soils of similiar derivation as those discussed throughout the northern section of this county. The land in many places is rough and stony while along the southern section it is more moderately rolling.

EARL, EAST EARL AND CAERNARVON TOWNSHIPS

Caernarvon township lies south of Brecknock on the Berks and Chester lines. The soils of this township are derived from the Mesozoic red shale in the northern part; from the Silurio Cambrian limestone in the central part and from the Potsdam sandstome and Micaceous shists in the southern part. The northern section is similar to the red shale soils previously discussed with similar capacities and adaptations. Along the line of contact between the limestone and the sands and shale, the land is fertile with deep, easily farmed soils especially adapted for raising wheat, corn and the clovers, among them alfalfa.

The Limestone Valley of this township is comparatively narrow with soils which, in part, are derived from remanents of the Mesozoic and outcropping of the Potsdam and Micaceous rock, together with the limestone. These soils produce large yields of hard, red, high milling quality wheat as well as large yields of superior well-ripened corn. The southern part of the township is covered by Welsh Mountain and much of the lands is rough with soils derived from the Potsdam quartzite and sandstone with some conglomerate and trap.

Wherever the land is not too stony and in many places where it is stony the soils are deep with fairly large water and fertility-holding capacity especially adapted for raising apples and peaches, the soils derived from Potsdam and Micaceous rock for apples and those not as rich and deep with trap intermixture for peaches, of which they will produce vigorous disease-resisting trees which will yield large crops of well developed, highly colored, nicely flavored fruit. This land should be devoted to fruit raising.

EAST EARL TOWNSHIP

This township lies west of Caernarvon township. Its soils are derived from the same rock formations as those of the township east of it, except that the Limestone Valley widens and the area of limestone soils becomes larger. In the northern part the soils are derived from the Mesozoic conglomerate and sandstone, where the conglomerate pebbles are small, mixed with a large quantity of loamy material the soils are deep and fertile, especially wherever some limy strata take part in its formation, adapted for raising all the regular

farm crops, especially the legumes, and among these, alfalfa. In the more sandy and rougher conglomerate formation where the soils are stony and sandy though fairly deep they wash readily, soon become dry and crops suffer for both water and fertility, because in the deeper sandy and gravelly soils both are carried beneath the reach of the roots of the plants and in the thin soils carried away by surface drainage and much of the water and fertility lost in this way.

The fertility should be applied in these soils in organic form with an early summer ripening cool weather cereal crop, such as rye, or timothy and clover, and with a hot and dry weather crop such as the cowpea, which can be successfully raised here. It can be raised as one of the catch crops after a crop of rye or hay has been harvested to take up and hold fertility in organic combination, which fertility, when the cow peas are plowed down will become available gradually as the plant with which the soils has been sown or planted will need it. What has been said here applies to all the conglomerates and sandy soils of the same character described and occurring in this county.

Throughout the central part of the township the soils are derived from the limestone formation and are fertile and very similar in capacity and adaptation to the soils in the limestone section of Caernarvon township. Several high hills in the eastern part of the township, the one along the northern border between the limestone formation formed of Mesozoic sandstone with fertile soils along its base; the other near the line of contact between the Potsdam sandstone and the Micaceous rock with soils, especially along the lower parts of the hill, derived from the three rock formations adapted to raising fruit, especially apples. In the southern part of the township the soils are derived from the same formations as those of the township east of this with similar adaptations and capacities.

In the following townships the areas of soils derived from rock other than limestone are limited and will be referred to in the discussions of the various townships. The townships and parts of townships with soils either largely or entirely derived from the decomposition of limestone, beginning with those bordering on the Susquehanna River, follow:

Southern Conoy, southern West Donegal, southern Mount Joy, southern Rapho, southern Penn, southern Warwick, southern Elizabeth, southern Clay, southern West Cocalico, western East Cocalico, northern Ephrata, southern West Earl, all of East Donegal, nearly all of East Hempfield, Manheim, Upper Leacock, Earl, Leacock, central and southern Salisbury, Paradise, West Lampeter, East Lampeter, Pequea, Lancaster, Conestoga, Manor and parts of West Hempfield. The townships, the larger part of the soils of which are

derived from the Mesozoic sandstone, shale and conglomerate, have been discussed, therefore, the limestone sections of these townships will be discussed in connection with the townships bordering on their southern lines.

EAST DONEGAL TOWNSHIP

This township lies south of Conoy, West Donegal and Mount Joy, with the Susquehanna River on its western boundary. A considerable area of river land, beginning in Conoy township, extends along the entire river front of this township, the soils of which are derived from sand and gravel at one time deposited by the river, but now from ten to thirty feet above the river level. These soils are deep, with large water-holding capacity, are sufficiently sandy and warm to admit of early cultivation and planting of early truck crops for the raising of which, when well supplied with manure for which they have a great liking, they are especially adapted and of which they produce large yields. These soils also produce good yields of a fairly thin velvety leaf wrapper tobacco, but are better adapted for the trucking business and for which they should be used. East of the river land, the land in this township is moderately rolling in many places, gently rolling with deep soils which do not wash, derived from the Silurio Cambrian limestone with large water and fertility-holding capacity, adapted for raising tobacco and all the regular cereal and clover crops of which they produce now, and have been producing, for a century and a half or more large yields, even in unfavorable seasons, because they are sufficiently loamy not to become cold and with such a distributive water-holding capacity that they seldom become too wet or too dry for plants to grow. With such especially adapted agricultural capacities, these soils will lend themselves to the highest developed intensive farming with such crops as will grow in the comparatively cold weather of the spring, the hot weather of the summer, the cool weather of the fall, taking advantage of the entire growing season of the year. The reason these soils are still so productive is because to them have been returned well nigh all the organic matter produced by them together with that part of the grain fel into animals and not utilized by them, in the best condition to yield fertility. The limestone soils of Conoy, West Donegal, Mount Joy and Rapho are similar to the East Donegal soils in derivation, capacity and adaptations.

EAST HEMPFIELD TOWNSHIP

East Hempfield township lies east of West Hempfield and south of Rapho townships. The soils of the northern and southern parts of this township are derived from the same underlying limestone

and are similar in capacity and adaptation. The central part of the township has soils similar to those of West Hempfield in connection with which they will be discussed.

WEST HEMPFIELD TOWNSHIP

West Hempfield township lies southeast of East Donegal, along the Susquehanna River. The soils of this township are derived from the limestone, the Potsdam sandstone and a Micaceous rock.

The limestone lands are more hilly and in some places stony with stones of Potsdam origin from the higher elevations, but the soils are equally as fertile with similar adaptation as the soils of East Donegal.

The Potsdam formation is hilly with some steeply hilly sections not adapted for farming, with comparatively thin soils, while on the rolling upland and along the more gentle slopes the soils are comparatively deep with fair water and fertility-holding capacity adapted for raising a hard, red, high milling quality wheat, but especially adapted for apple raising, of which these soils produce vigorous disease-resisting trees, yielding large crops of well developed, highly colored, nicely flavored fruit. These soils are similar to those of Caernarvon township, to which the reader is referred.

MANHEIM TOWNSHIP

It lies east of East Hempfield and south of Warwick and Penn townships. The soils of the township are derived from the same limestone formation as those of East Donegal, with a more clayey type occurring, together with the loamy soils of East Donegal township which are equally as productive as the more loamy soils of that township—in fact—they are said to endure abuse for a longer time than the loamy types. These more clayey soils produce large yields of wheat. But in order to maintain these yields it is absolutely necessary that the wheat raised in these soils should be winnowed sufficiently hard to remove all light colored and light grains from the wheat to be used for seed or that seed wheat should be gotten from the soils that produce the heavy, hard, red, high milling quality, every three or four years. In order to produce as large yields of a high feeding quality corn in these soils, more cultivation than in the more loamy soils is required so as to keep the soil open and porous to furnish air for the large rooting system of the corn plant.

These are the largest hay-producing soils of the county, especially timothy and clover hay combined. They are not the best clover soils, not as good as the more loamy types, but having the capacity to hold on to fertility until demanded by a growing plant, these soils do not need to have fertilizing substances supplied as con-

tinuously as the soils that do not hold fertility with the same tenacity. Alfalfa thrives fairly well in these soils but does not last as well as in the more loamy types. Tobacco yields large crops, but not as high a quality as in the more loamy soils. Two narrow ridges, the southern of Hydro-mica shists and sandstone and the northern composed more of sandstone, occur in this township near Neffsville with soils similar to those of the quartzite and Micaceous rock of Hempfield townships.

The limestone soils of Penn, Ephrata and Warwick townships, previously located and discussed, are derived from the Lancaster limestone, with both the clayey and loamy types occurring, with similar capacities and adaptations as those occurring in the townships already described and, therefore, need no further reference here. The Mesozoic or what seems to be Hydro-mica slate areas in the southern parts of these townships have some splendidly fertile soils along the line of contact between the limestone and slate easily farmed, adapted to raising a large variety of crops, such as the long and short season cereal grains and clovers though they do not produce as large yields of any of these crops as do the loamy or more clayey of the soils derived from the limestone strata, exclusively, while the shaly and sandy soils wash easily, are thin with small water and fertility-holding capacity, and not as large crop yielders.

WEST EARL TOWNSHIP

This township lies east of Warwick and south of Ephrata. Its soils are derived well nigh entirely from the limestone formation with both the clayey and loamy types occurring with similar capacities and adaptations.

UPPER LEACOCK AND LEACOCK TOWNSHIPS

Upper Leacock township lies east of Manheim and Lampeter, and Leacock lies south of Upper Leacock. The soils of these two townships are nearly all derived from the Lancaster limestone, with both the loamy and clay loams occurring similar in fertility and in productive capacity as those of the townships previously discussed. The loamy soils prevail largely in Upper Leacock except near Mechanicsburg where a stony and sandy ridge remains with soils derived from the same sandstone occurring in West Hempfield township with similar capacities and adaptations.

SALISBURY TOWNSHIP

Salisbury township lies east of Leacock and south of East Earl on the Chester county line. The soils of this township are derived in the northern part from the sandstone rock of the Gap Hills and

Welsh Mountain, discussed under Caernarvon and East Earl townships. The land is not as steeply hilly generally in the northern part of this township as in the townships previously discussed, and is more easily farmed and adapted to a larger variety of farm crops, but the more hilly and stony land, of which there is a considerable area, is especially adapted for raising apples. The same soil occurs along the eastern border of the township and swings round to what is known as the Gap on the Pennsylvania Railroad.

The more rolling sections of this sandy land along the eastern border are not as fertile as in some other places, because a tough clay combines with the sand which, in many instances, is wet and cold, which delays farming operations in the spring and becomes hard and dry in the summer and interferes with farming operations at this time. The soils of the limestone valley between the Potsdam formation at the Gap and the same formation in the northern part of the township, belong largely to the loamy type with similar capacities and adaptations, except in the southern part of the valley where the Micaceous limestone comes in to be discussed later.

A trap dyke, with a number of outcrops through this limestone valley, crosses the western part of this township, making narrow sections of deep, stony, loamy soil with splendid water-holding capacity in which the operations of disintegration are going on at such a rate as to make available a considerable amount of fertility.

East Lampeter, West Lampeter, Lancaster, Manor, northern Conestoga—all but central Pequea, Strasburg and northern Paradise have soils derived largely from the Lancaster limestone.

EAST LAMPETER TOWNSHIP

East Lampeter township lies east of Manheim and Lancaster townships and west of Leacock. The land in this township is gently rolling, with clayey soils derived from the Lancaster limestone in the northern section, while in the southern part the Micaceous material, from which the soils of the southern section of the county are derived, appears in the formation. These soils in the southern part are loamy and are very similar to the loamy soils of East Donegal, except as a whole, they are not as deep but are equally as fertile as the soils of East Donegal, with large water and fertility-holding capacity, especially the deeper soil, and can be cultivated early and are easily farmed and adapted to the extremes of the varieties of both cereal and leguminous crops that thrive under prevailing climatic conditions. Among the latter, alfalfa seems to make a more vigorous and lasting growth in these soils than elsewhere, likely, because they contain more lime than the other loamy and the clayey soils do. A considerable area of the land in this township has been farmed for

two centuries, and is being farmed at this time and produces as large or even larger crops than it did at any previous time. These are among the best tobacco soils in the county.

WEST LAMPETER TOWNSHIP

This township lies southwest of East Lampeter and east of Lancaster township. The land in this township is moderately and much of it gently rolling with deep soils with large water and fertility-holding capacity derived from the Lancaster limestone with, especially in the southern part of the township, a considerable amount of Micaceous slates mixed with the limestone which does not decompose as readily as the limestone and, therefore, the land becomes more hilly in the southern part of the township. These soils are especially adapted for raising corn and tobacco, being more loamy; and among the long season, leguminous crops, red clover and alfalfa, and among the short season legumes, the cowpea, the soja bean and the Canada field pea yield large crops, especially the Canada field pea, when sown early, as it usually can be on account of the warm, loamy condition of the soil, which makes early cultivation possible in all but the clayey types. With soils adapted for raising an array of crops like those just enumerated, the limits of production, even in this land considerable areas of which have been farmed for two centuries by families of the same name who have been among the best farmers of this county, has not been reached to the best of the writer's knowledge anywhere throughout this section.

LANCASTER TOWNSHIP

This township lies east of East Lampeter and northwest of West Lampeter. The city of Lancaster, the county seat of Lancaster county, is located in this township and is one of the oldest towns in the State. The land in this township is moderately and much of it, gently rolling, with deep clayey and loamy soils, with large water and fertility-holding capacity adapted, the more clayey types, to the same crops as those discussed in connection with Manheim, East Lampeter and several other townships, while the loamy soils are adapted to the same crops as those discussed in connection with West Lampeter township. Much of this township is being cut up into smaller farms and considerable trucking is being done for which these soils, especially the loamy types, are as well adapted as for raising the regular farm crops, for which, because of the demand for such crops in the city of Lancaster and surrounding villages and towns, a large part of this land should be used.

A considerable area of this township has been farmed for two centuries, and these sections are as productive as they were at any time because of the natural fertility of the soils, which these farmers

throughout the long years they have farmed these soils have maintained by returning to these soils, in as large quantity as possible, and in the best condition, the organic matter, together with the excrement of the animals in the best condition for the soils to utilize both. This practice has been followed in well nigh the whole of the limestone section of this county.

MANOR TOWNSHIP

Manor township lies west of Lancaster and south of West and East Hempfield, bordering on the Susquehanna River.

The soils of this township are derived from the Lancaster limestone and the limestone shales and the Hydro-mica shists. The ridge made by the Hydro-mica shists, beginning south of Columbia and extending eastward beyond Mountville has soils, along the slopes, derived from both the limestone and these slates, some of them deep with large water and fertility-holding capacity, adapted to raising the regular farm crops, as well as they are adapted for raising any other crops, while on the higher rolling elevations the soils are derived from sandstone and slates, and where they are not washed, are fairly deep with fair water, but rather poor fertility-holding capacity, adapted best from raising crops, such as rye, that mature before the usual dry weather of the summer sets in and for raising dry weather crops such as cowpeas among the clovers and probably Kaffir corn among the summer cereals. These soils will also produce apple and peach trees that make a vigorous growth, but the more slaty types are not as well adapted for raising fruit as the Potsdam sandstone soils are. Along the ridges and the steeper slopes the land is usually stony and rough, but there are only small areas where these soils occur.

South of this formation the soils are derived from the Lancaster limestone and limestone slates similar in derivation, capacity and adaptation, except that the slopes along the streams are steeper and the soils washes more readily, and in order to prevent this, hillside farming should be done in some sections along these streams.

In the southwestern part of this township, along the river, south of the river land, discussed in connection with East Donegal township, Turkey Hill rises approximately two hundred feet above the river bank with soils derived from a formation quite similar to that further south and southeast a Chloritic Shistose rock but of which the hills especially along Conestoga creek, and, as previously indicated, along the Susquehanna River are steeper and rise higher. The soils along the hillsides wash badly and either hillside farming should be practiced or these hills should be entirely converted into forest land for which they are well adapted. The more moderate slopes and the rolling uplands have comparatively deep soils with fair

water and rather good fertility-holding capacity, adapted to the raising of the regular farm crops of which with the application of manure and by the plowing down of sods these soils will produce during normal season fair yields.

This land can be plowed early in the spring and sown with an early summer ripening crop, such as early oats or planted with early potatoes, which can be taken up before the hot and dry weather of the summer injures them or a crop of hay can be harvested and potatoes plowed in with the sod sometime the middle or latter part of June and a late potato crop raised, or the sod can be plowed down and a crop of cowpeas raised, which will endure the dry weather better than the second year grass sod and produce a second crop of roughage which can be harvested early enough for the land to be sown with rye in the fall. This is rather intensive farming for soils of this type but, if the organic matter derived from the crops of the latter arrangement is returned to these soils, they will show results on a large scale such as have been realized only locally where such practices have been followed for sometime.

It seems that Kaffir corn would thrive on the poorer and dryer of these soils, yielding a larger amount of grain with a higher feeding value than the ear corn, while on the deeper and larger fertility and water-holding soils the ear corn will make larger yields.

PEQUEA TOWNSHIP

Pequea township lies east and south of Lancaster, south and west of West Lampeter. The soils of this township are, with the exception of a strip in the central part of the township, derived from the Lancaster limestone and are similar to those previously discussed and to be discussed.

CONESTOGA, STRASBURG AND PARADISE TOWNSHIPS

All lie along the boundary line or the line of contact and overlapping of the slaty limestone and Azoic rock and have soils derived from these formations.

CONESTOGA TOWNSHIP

Conestoga township lies south of Manor, along the Susquehanna River. The northern half of this township lies in the Lancaster limestone and slaty limestone formation, with deep fertile loamy soils, with large water and fertility-holding capacity derived from these underlying rock, adapted for the raising of similar crops as those mentioned in the discussion of West Lampeter township.

This land may be more hilly especially along the line of contact of the two formations than in the townships previously discussed, but it is equally as fertile, naturally, as is evident in the crops that

are produced where the soils is not washed away, but where washing has taken place crop yields have been materially reduced, especially has this happened within the last decade. A trap dyke, small in area and similar in character to that near Millersville, comes to the surface below Safe Harbor, but has little effect on the character of the soil. The soils derived from the Azoic rock will be discussed later.

STRASBURG TOWNSHIP

Strasburg township lies east of West Lampeter and Providence. The soils of this township are derived from the Lancaster limestone, except on the southern boundary, and are similar to the soils of Conestoga township and adapted for raising as successfully as in that township or equally as successfully as in West Lampeter the crops enumerated there. The land in some sections of this township has been farmed for two centuries and is equally as productive as the land of the other township which has been farmed for the same length of time.

PARADISE TOWNSHIP

Paradise township lies east of Strasburg and south of Leacock. The northern part of this township lies within the Lancaster limestone formation with soils derived from this limestone similar in capacity and adaptation to the soils of Conestoga and Strasburg townships, especially the latter. These limestone soils are equally as, or even more fertile than the limestone soils of Adams, Berks, Cumberland, Franklin and other counties in southeastern Pennsylvania and, as indicated in the discussion of these counties, are adapted to a type of intensive farming along the dairy and other animal industry lines or that of the production of the cereal grains not surpassed anywhere in this or any other state.

I have handled ears of corn produced in this county that when dry, shelled 24 ounces or a pound and a half of corn. This may be the limit of the productive capacity of these soils under the best conditions, but suppose it would be if every stalk on every acre of corn raised within the limits of the limestone area of the county in a normal season would produce an area that would when dry shell only a pound, the yields of corn in the limestone area would be doubled. There is something to strive for in Lancaster county even though she is the banner county of the United States.

The following townships and parts of townships in the southern part of the county have soils derived from the Azoic rock: Sadsbury, Bart, Eden, Providence, Martic, Drumore, Colerain and Little Britain.

SADSBURY TOWNSHIP

Sadsbury township lies south of Salisbury on the Chester county line. The soils as, previously indicated, are derived from the Azoic rock, except a narrow strip of the Chester Valley limestone which crosses the central part of the township.

The northern part of the township, as previously indicated in the discussion of Salisbury township, is hilly, especially in the vicinity of the Gap. The ridge known as the Gap Hills is stony, sandy and the soils in the northern part of thin, poor and some are spouty, cold and not productive unless carefully farmed; while the more Micaceous in the more moderately rolling sections of this part of the township are fairly fertile, deep, with good water-holding capacity, adapted for raising wheat of which they will produce large crops of a hard, red, high-milling quality. These soils will also produce large yields of corn of splendid quality.

The legumes, especially red clover and alfalfa, yield splendid crops when the land is thoroughly prepared and a little lime applied. Throughout the central part of the township the land is moderately rolling, with soils derived from a combination of the remaining limestone and the sandstone and the Gneissic rock, which are deep with large water and fertility-holding capacity, adapted for raising corn and the legumes, especially red clover and alfalfa among the long season crops and the cowpea, the soja bean and the Canada field pea among the short season, when sown early with oats.

BART TOWNSHIP

Bart township lies west of Sadsbury and south of Paradise. The northern part of this township and the southern part of Paradise lie within the sandstone area of this formation, with sandy and stony soils derived from a Feldspathic sandstone similar to that occurring in Chester county, and referred to in the discussions of the various townships in which it occurs in that county. These soils are stony along the more elevated sections, and in some places on the moderate slopes with loam and clay mixed with the stones and gravel, not a satisfactorily productive agricultural soil, but splendidly adapted for forest growth and for raising vigorous disease-resisting apple trees, which usually produce large yields of nicely-colored and flavored fruit. These same soils extend into Sadsbury township. South of this sandy formation the soils are similar with similar capacities and adaptations as those previously discussed in Sadsbury township. A trap dyke crosses the northern part of this township in a southwestern course, and while it is comparatively narrow, its effects are quite noticeable, especially in the vicinity of the old Nickel Mine, where a section of low and spouty land occurs with large boulders

of Syenitic rock covering the surface, making soils of little farming value, while the soils immediately paralleling this dyke are fairly fertile and adapted, the more elevated for raising fruit.

EDEN TOWNSHIP

This township lies west of Bart and south of Strasburg and Providence. In the northwestern corner of the township the soils are similar in derivation, adaptation and capacity as the stony Feldspathic soils of northern Bart township; while southward and along the Limestone Valley, at Quarryville, the land is more rolling with deep soils, with large water and fertility-holding capacity adapted for raising the same crops as the soils lying along the same formation in the townships eastward previously discussed.

PROVIDENCE TOWNSHIP

This township lies west of Eden and south of Strasburg. The soils, except along the northern and the northwestern border, are derived from the Azoic rock. Along the contact between the limestone and the Azoic, the land is hilly with numerous outcrops of the Azoic rock along the crests of these ridges, while along the lower and also along the upper slopes the slaty limestone very much twisted outcrops and enters into the formation of the soil which washes more readily than any limy soil in this or any other county. In the central and southern part of this township the upland between the streams is moderately rolling, with deep soils with such water and fertility-holding capacity that will usually carry a crop of corn through a dry season, if a surface mulch of fine earth is maintained and even in the deeper soils without such a mulch.

These moderately rolling uplands throughout this entire formation are among the best corn soils in this or any county of the State. The largest yield of corn, of which accurate account has been kept during several years, have been raised on these soils. It seems that the processes of disintegration are going on at such a rate in these soils that a sufficient amount of whatever fertility is contained in the rock is being made available during the year for the use of the plant which, wherever the soil is not washed away, has a tendency to maintain a supply of available plant food as long as the rock endures.

The following analyses of a Mica schist may give some idea of what may result from the distintegration of this rock:

Loss by ignition, ...	1.99 per cent.
Silicic acid, ...	76.12 per cent.
Titanic acid, ...	0.23 per cent.

Phosphoric acid,	0.05 per cent.
Alumina,	13.45 per cent.
Ferric oxide,	1.86 per cent.
Magnesia,	1.22 per cent.
Lime,	0.33 per cent.
Soda,	1.40 per cent.
Potash,	4.08 per cent.

MARTIC TOWNSHIP

Martic township lies west of Providence and south of Conestoga, along the Susquehanna river. In the northeastern part of the township, like Providence, the soils are derived from the limestone, and are similar in capacity and adaptation to these soils or to the soils of southern Conestoga. Southward the land is very hilly, being traversed by several ranges of hills having a northeastern and southwestern course, with steep sides several hundred feet above the general level, with moderately rolling land on top, with fairly deep soils in which the regular farm crops will produce fair yields. It seems that with the agricultural practice to which these soils will lend themselves, that better results could be obtained by adopting a rotation in which soils improving crops, such as the cowpea and the soja bean and the winter vetch should occupy at least secondary positions. The cowpea could come after rye and be plowed down and seeded with rye and winter vetch and this followed with soja bean or corn.

Apple and peach trees make a vigorous growth and will produce large yields of well-developed, well-colored, fairly well flavored fruit. These are among the best fruit soils in this section and should be largely devoted to raising apples.

DRUMORE TOWNSHIP

Drumore township lies southeast of Martic, along the Susquehanna River. The township is not as hilly as Martic, especially not at some distance fromt the river. Chestnut Level serves as a splendid illustration of a moderately and gently-rolling upland, with deep, fertile loamy soils derived from the Micaceous rock, with large water and fertility-holding capacity adapted for raising corn, of which it produces large yields of a superior quality. This soil is also adapted for raising the legumes, especially alfalfa and red clover, among the long season crops, and the soja bean and the cowpea among the short season. With corn, alfalfa, soja bean and cowpea, crops, the very best for feeding all animals, there should be no trouble to feed more than twice the animals than are fed at the present time in this township.

Not all the land in this township is as fertile as that of Chestnut Level; but the less stony and rolling upland, with soils of similar derivation, can be brought to a higher state of production than it has at present by the use of the crops suggested. Potatoes also yield large crops of a mealy type.

COLERAIN TOWNSHIP

Colerain township lies south of Bart and Eden and northeastward of Drumore townships on the Chester county line. The soils of this township are derived from the Mica schist rock, which form steep hills along the Octorora and the West Branch of the Octorora creeks. On the divide between these creeks is one of the rolling uplands referred to in Drumore township, as Chestnut Level, with similar soils but not as fertile because they are more sandy with less of the loamy element apparently derived from a more sand rock but adapted for raising the same kind of crops of which they will during, a favorable season produce equally as large yields.

LITTLE BRITAIN TOWNSHIP

This township lies south of Drumore and Colerain on the Chester county line. The land in the northern part of this township on the upland is moderately rolling with deep, fertile, early, easily-farmed soils derived from the Mica schist rock, adapted for raising the crops enumerated in Drumore township.

The central and southern parts of the township have the same rolling upland, with deep soils above referred to, derived, some from the Hydro-mica schists which, wherever this is the case, are usually not as fertile as the soils derived from the Micaceous schists. The soils usually are equally as deep, but are not as warm and loamy as the Micaceous soils are and can not be cultivated as early and do not respond to good agricultural treatment alone, but do respond to an application of manure and the plowing down of organic matter which, therefore, together with thorough cultivation, should be made the method of improving these soils so as to get better returns or returns equal to those of the Micaceous soils.

FULTON TOWNSHIP

This township lies west of Little Britain, with the Maryland line for its southern and the Susquehanna River for its western boundary. The land in this township, especially in the central and eastern part, is fairly moderately rolling, with deep, loamy, warm, early-farming soils, with large water and fertility-holding capacity, adapted for raising all the regular farming crops, but especially adapted for raising the legumes, previously enumerated, and for raising corn, of which it will produce large yields of splendid quality.

South of the Chloritic schist formation, in the central and eastern part of the township, the Conewingo Creek cuts through a ridge of Serpentine rock which is known as the "Barrens," because of the absence of well nigh all vegetation except mosses and scrubby growth where some disintegration has taken place. The soils, derived from this Serpentine rock are the poorest in this county. And will not produce agricultural crops.

South of the Serpentine ridge, the Conewingo Creek flows in a valley of Hydro-mica and Chloritic schists, the soil of which is effected by the evil influences of the Serpentine rock, which forms ridges on both sides of the valley through this township and into Maryland. The western part of the township, along the river, is hilly, with some uplands of rolling soil equally as fertile as the rolling land in the central and eastern part of the township, and more accessible.

The early history of this township is important. According to a series of articles contributed to the Oxford Press, January 12 (by Dr. C. H. Stubbs, of Wakefield, this township), Captain John Smith landed in this township in 1608 and ascended the river as high as the northern limits of the township. Claireborn located a trading post on the east bank of the Susquehanna in 1631. Hence Fulton township holds the prestige of being the first part of Pennsylvania visited by the whites seventy-five years before the landing of Penn on the Delaware.

On the hilly and stony soils of this township as well as on the similar soils of other townships in this southern section of Lancaster county, with climatic conditions such as prevail here, it is possible to raise a crop of rye and winter vetch, cut these for hay or for silage in May, sow the land with cowpeas, pasture these or cut them for hay or silo them and sow the land with rye and vetch, and if necessary plow this down the following spring, and after cutting up the rye with a disk harrow when it is plowed down and applying some lime and phosphoric acid, plant with corn. A rotation of crops can easily be worked out with crops of this kind that will make more roughage and grain than present methods of farming are yielding and at the same time improve the soil.

DRAINAGE.

The county is drained in the northern part by Chikis Creek, and smaller streams, the Little and Big Conestoga, which rises in Chester county, and flows southeastward and drains part of the central part of the county, while the Pequea Creek drains the eastern, central and south central part, and the Octorora and its western branch drain the southeastern part, and the Conewingo with smaller streams the southern part, all flowing into the Susquehanna River.

YORK COUNTY

York county was erected by Act of the Assembly, August 19, 1749, being separated from Lancaster county. In 1800, its limits were curtailed by the separation of Adams county, after a long controversy between the Irish and the Germans, and the political differences between the eastern and western sections. Agricultural operations were begun in this county as early as 1722, throughout the fertile limestone valley between Wrightsville and York; therefore, there is land in this county that has been farmed for nearly two centuries and is still yielding splendid returns.

It contains 577,920 acres, of which 532,017 acres is land in farms, and of which 433,483 is improved farm land. 78,597 acres were planted with corn in 1909, yielding 2,402,419 bushels; 26,528 acres sown with oats, yielding 799,354 bushels; 83,920 acres sown with wheat, yielding 1,818,050 bushels; 741,741 acres with buckwheat, yielding 10,802 bushels; 12,342 acres with rye, yielding 191,199 bushels; 10,841 acres were planted with potatoes, yielding 732,112 bushels; 6,134 acres were planted with tobacco, yielding 6,281,294 pounds; 92,463 acres sown with all forage crops, yielding 101,047 tons of the various kinds of hay. At this time, York county had a population of 136,405 to feed, 45,743 cattle, 16,680 horses, 8,156 mules, 48,073 swine and 4,120 sheep.

This county lies south of Cumberland, east of Adams, with a frontage on the west bank of the Susquehanna River of more than fifty miles, and a distance along Mason and Dixon's Line of forty-two miles. The underlying rocks from which the soils of the county are derived, embrace the Azoic slates, the Peach Bottom roofing slate, the Chloritic schists, the Potsdam quartzite, the Hydro-mica schists, the Silurio Cambria limestone, the new red sandstone and shales and the trap dykes and a small section of Marl in the vicinity of Dillsburg.

The county is drained in the northern border by the Yellow Breeches Creek and its tributaries; in the northern central part by the Conewago and the Little Conewago creeks; in the central and southwestern part by the Codorus Creek and its tributaries and the southern part by Muddy Creek and its branches. All these and a number of smaller streams, not named here, which drain the territory closer to the river flow into the Susquehanna River.

The county divides itself into three approximately equal sections: First, the northern townships or the Mesozoic shale and sandstone, together with the trap ridges region; second, the central or the Potsdam sandstone, Silurio Cambrian limestone and the Hydro-mica schist region; third, the Chloritic and Gneissic schist region.

FRANKLIN AND CARROLL TOWNSHIPS

Franklin township occupies the northwestern corner of the county and has the Cumberland county line for its northern and the Adams county line for its western boundaries. In the western part of the township the South Mountain terminates west of the Susquehanna River and does not reappear until Lebanon county is reached. The strata of the Mesozoic are deposited against the slope of this mountain and take part in the formation of the soils.

Along the eastern slope of the mountain, or hill, as it might here be called, the soils are derived from the Potsdam sandstone, especially along the lower slopes and the Azoic slates, a combination in which apple trees make a vigorous disease-resisting growth, yielding large crops of well-developed, highly-colored and nicely-flavored fruit. These soils, especially the poorer types, also produce vigorous peach trees which yield large crops of well-developed, nicely-colored, well-flavored fruit. But the soils are better apple than peach soils. At the foot of the mountain the soils are a heavy clay well nigh all of which needs underdraining, and when underdrained the soils become quite productive, producing fairly large crops of wheat especially when limed.

Timothy hay and the other grasses also thrive in these soils. East of the foot of the mountain in this township the trap rock comes to the surface and from it, together with the Mesozoic shale, the soils are derived. The soils are in some places stony but are deep and loamy with large water and fertility-holding capacity, adapted especially for raising peaches of which they produce vigorous disease-resisting trees which yield large crops of well-developed, nicely-flavored and colored fruit.

The gray shales of the Mesozoic Age largely prevails in this township produced by the intrusive trap which has not reached the surface. These soils are among the better wheat soils in this section, if not the best. They produce fairly large yields of a hard, red, high-milling quality wheat. They also produce a splendid quality of corn, but the yields are usually not as large comparatively as the yeild of wheat. Timothy, and when lime is applied or intensive cultivation practiced the clovers also thrive in these soils.

These soils have a tremendous hunger for organic matter, and will not only for their own benefit, but for the benefit of the farmer, consume large quantities of it and return in crops splendid dividends on the investment. For this reason this land should be farmed so as to produce as large quantities of organic matter of high quality which should either be fed to animals or used as absorbent for animals excrement and returned to the soils in the largest quantities possible. Rye and the winter vetch should be raised and used for

silage or hay or plowed down and the land limed and sown with cowpeas and these made into hay and the land sown with wheat, to be followed with timothy and clover. This is simply suggestive, other methods equally as good or even better for obtaining organic matter are available.

CARROLL TOWNSHIP

Carroll township lies east of Franklin, with the Cumberland county line for its northern boundary. The terminous of the South Mountain extends into the township with similar soils, with similar capacities and adaptations as those of Franklin township. A deposit of Marl occurs east of this mountain in the vicinity of Dillsburg, in fact, the town is built on the deposit and from it the soils in this part of the township are derived. These soils are deep, some loamy and clayey with large water and fertility-holding capacity, adapted for raising all the regular farm crops, but especially for raising corn, wheat, the legumes, the red clover and alfalfa among the perennials, and the soja bean and the cowpea and the Canada field pea among the annuals. Crimson clover also thrives here.

Along the northern boundary the slaty limestone, coming in from the Cumberland county, outcrops, and in connection with the Potsdam and the trap rock, the three of which occur here, enter the formation of the soil, making a peculiarly fertile, deep soil with large water and fertility-holding capacity, adapted for raising all agricultural crops and also adapted for raising fruit. In the northwestern corner and along the southern border of the township the trap rock comes to the surface and the soils in these sections are largely derived from this and the Mesozoic which has been so much changed that it is not readily recognizable.

The land throughout this township is moderately rolling and fertile, with deep soils, adapted for the production of all farm crops. A considerable area of this land has been planted with apples and peaches and large yields of well-developed, well-colored and nicely-flavored fruit has been produced.

MONAGHAN TOWNSHIP

This township lies east of Carroll, with the Cumberland county line for its northern boundary. The soils of the township are derived from the trap rock which covers all but the southwestern and the northeastern sections where the Mesozoic gray shales make the basis of the soils. The land in this township is hilly and some of it rough and stony, but the soils are deep, and wherever sufficient loam is mixed with the stones and gravel, making stony and gravelly loams,

some of the best peach and apple soils of this section occur, which produce vigorous disease-resisting trees yielding large crops of well-developed, highly-colored, nicely-flavored fruit.

The gray shale soils of the southern and northeastern parts of the township are especially adapted for raising wheat, of which they will produce large yields of a hard, red, high-milling quality. These soils will also produce vigorous fruit trees, but do not have the special adaptations such as the trap soils have, all of which is manifest in the vigor of the trees and the fruit.

FAIRVIEW TOWNSHIP

This township occupies the northernmost corner of York county, with the Cumberland county line for its northern and the Susquehanna River for its eastern boundary. The land is hilly, except some parts of the limestone section in the northern part and a part of Lewisberry and Fishing creek valleys, which are more moderately rolling. The soils are derived from the limestone, the Mesozoic red and gray shales and sandstone and the trap rock. The soils derived from trap rock are similar to those of Monaghan township, and are adapted for raising the same crops except on the southeastern slope of the trap dyke along the river where some deep, warm, loamy, early-farming soils, with large water and fertility-holding capacity, occur, especially because of location, adapted for raising early market gardening crops. These soils are strong enough with the right kind of treatment to produce a number of these crops arranged in accordance with their seasonable adaptation during the growing season which, with the markets of the immediate vicinity, should be done. The more slaty, shaly and loamy limestone soils along the line of contact between the limestone and the Mesozoic are splendidly adapted for raising potatoes and should be used for raising this crop because of the demand in the local markets.

A rotation of clover, potatoes and wheat should give inviting returns. The more clayey limestone soils are adapted for the same kind of farming as the soils of the limestone valleys of this county, for a discussion of which, see West Manchester township.

In Fishing Creek Valley the land is not as hilly as along the trap formation. The soils are fairly deep, but usually sandy, except in the valleys along the streams where some clays occur, while the gray shaly soils, which accompany the trap dykes, are loamy, with injections of trap rock and are usually more productive, adapted, as stated under the discussion of Monaghan township, especially for raising wheat. The sandy types of the Mesozoic will produce, when organic matter is supplied, fair yields of potatoes.

These soils need a large supply of organic matter to continue producing inviting crops of potatoes. Usually a clover sod alone does not furnish a sufficient amount of a high type of organic matter to supply what is needed and therefore recourse must be had to raising several short season clovers by sowing rye and crimson clover or rye and winter vetch after the potatoes are taken up and plowing these down the following spring sowing the land with cowpeas or planting with soja beans, harvesting these for grain and roughage and sowing the land with wheat, to be followed with clover; and after cutting a crop of hay the following summer, plowing down the clover sod for potatoes the following spring. Such an operation, with the use of finely ground limestone and commercial fertilizer, should produce inviting returns. A succession of crops as here indicated is equally well adapted for raising corn and the hay grasses. The rye and the clovers after being plowed down must be thoroughly cut up with a disk harrow to get best results.

NEWBERRY TOWNSHIP

This township lies south of Fairview, with the Susquehanna River for its aestern boundary. A trap dyke traverses the township from its southeastern to its northwestern corner, with soils similar, with similar capacities and adaptations to those of the same derivation previously discussed, except that several miles northwest of York Haven, a small area of clayey, low spouty land occurs which needs underdraining, and unless underdrained, is of little agricultural value, which is the case with about all spouty lands wherever they occur throughout these trap dykes because the soils are cold and wet in the spring; hard and dry and hot during the hot and dry season of the summer both most unfavorable conditions for the growing of agricultural plants. The Mesozoic land at such places as Goldsboro is hilly, stony and in many places rocky until the more rolling upland is reached, otherwise the soils are similar to those previously discussed.

WARRINGTON TOWNSHIP

This township lies west of Newberry and south of Monaghan and Carroll. It contains a larger area of soils derived from the trap rock than any township in the county, and wherever the trap does not come to the surface the overlying red shale and sandstone has about all been changed to the gray shale and sandstone and has been so broken up that the soils are deeper, more fertile and more easily farmed with larger water and fertility-holding capacity.

The more steeply hilly, rocky and stony land should remain in forest, for the production of which it is admirably adapted, while

the less steeply hilly and rocky should be largely used for raising apples and peaches, of which it produces vigorous disease-resisting trees which yield large crops of well-developed, well-colored, nicely-flavored fruit.

The more moderately rolling of the trap and gray shale soils are also adapted for raising the regular farm crops, especially wheat, corn, and by the application of some lime, the legumes, among the long season the red, alsike, mammoth and alfalfa and among the short season or annual hot weather crops the various varieties of cowpeas and soja beans and for the cool weather annuals the winter vetch, the Canada field pea and crimson clover. Timothy also yields splendid crops of a good quality hay in these soils. Potatoes, if the soils are treated as indicated under Newberry township, also yield inviting crops in both the loamy trap and gray shale soils.

WASHINGTON TOWNSHIP

This township lies west of Warrington, south of Franklin, with the Adams county line for its western boundary. The land in this township in the eastern part, north of Halls, is moderately rolling with soils underlaid with impervious red shale and sandstone, which is drained in Paradise and Dover townships. The trap dyke running along through Warrington township crosses this township into Adams county with similar soils with similar capacities and adaptations as those previously discussed.

DOVER TOWNSHIP

This township lies east of Paradise and Washington. In the northern part of the township the Conewago Hills make a rough, stony and hilly section, with soils derived from the harder sandstone of Mesozoic Age, not adapted for raising farm crops, but rather adapted for forest growth, for which it should be used. Along the foot of these hills the land becomes more moderately rolling, but the soils usually are thin, either underlaid with sandstone or shale, both impervious to water and, therefore, these soils soon become saturated with water during wet seasons and soon become dry in dry seasons so that considerable ingenuity is required to handle these soils, agriculturally, successfully. It should not be expected that these soils will continue much longer producing successfully three soil-exhausting crops, wheat, oats and corn in succession, therefore, in connection with these soil-exhausting crops or following them, soil-improving crops should be raised, not by any means an easy undertaking because they are wet and cold in the spring and hot and dry in the summer—conditions which few soil-improving crops can endure. The cowpea, the soja bean and the winter vetch, in con-

nection with stable manure, should and could be made the means of improving the soils. Through the central part of the township is a moderately and, in many instances, a gently rolling section with sandy, and in the more moderately rolling sections, loamy and the gently rolling sections clayey soils ranging in depth from a foot to a number of feet, adapted for raising the regular farm crops, but the clayey soils, especially adapted for raising timothy hay. A rotation such as has been suggested for these soils in Adams county in which timothy hay should be one of the money crops, should be worked out for this section. The gently rolling land referred to is known as "Holtz Schwamp" which begins in Paradise township, to which the reader is referred to for further discussion.

CONEWAGO TOWNSHIP

This township lies east of Dover and south and west of Newberry. The Conewago Hills, discussed in connection with Dover township, cross the northern part of the township with similar soils, with similar capacities and adaptations which is true of the more rolling section also discussed under Dover township.

A number of narrow ridges along which the trap rock outcrops occur throughout the southern part of the township, with soils splendidly adapted for raising peaches and apples, of which they will produce vigorous disease-resisting trees yielding large crops of well-developed, well-colored, nicely-flavored fruit. A number of these ridges have been planted with fruit and splendid returns are realized. The red shale and sandy soils also produce a fair quality of peaches and apples; but the trees are not as vigorous and do not yield as well developed and superior quality of fruit.

In the vicinity of these trap outcrops the gray shales, previously discussed, occur with deep soils, with large water and fertility holding capacity adapted for raising the regular cereal crops, and among the clovers, alfalfa. This crop has been successfully raised for a number of years on the red shale and red sandy comparatively deep soils in Manchester township in the vicinity of Manchester. The red shale soils of Conewago township are similar to the same types of soils previously discussed.

PARADISE TOWNSHIP

This township lies west of Jackson and south of Washington, with the Adams county line for its western boundary. The soils of the township, with the exception of a small section near Farmer's Post-office, are derived from the Mesozoic red shale and the Potsdam sandstone. The northern and central parts of the township are within the Mesozoic formation, while the southern and partly the central are in the Potsdam sand.

In that part of the township in which the soils are derived from the Mesozoic red shale and sandstone, the land is moderately rolling and some even gently rolling, in such places as Holtz Schwamp, with fairly deep soils in the more moderately and gently rolling section with good fertility but poor water-holding capacity, while the more hilly sections have thin soils with still poorer water-holding capacity. In both the gently and moderately rolling and hilly sections the soils rest on the underlying shale or sandstone and vary in depth from six inches on the steeply hilly formations to a number of feet in the gently rolling. These soils readily become saturated with water and therefore during the spring season of heavy rainfall or any other season of heavy rains these soils are wet, and not only are they wet but all the water that can not penetrate the soil and be held there is lost by surface drainage, which causes washing and carries with it both soil and fertility.

With soils of this type farming operations should be handled so as to conserve the moisture and prevent washing by having such root crops constantly growing in the soil as will hold it and by having such a quantity of organic matter constantly there that will hold a sufficient amount of water to carry a crop through a normally dry season. These may be ideal conditions, but crops can be so arranged that during a normal season these results can be at least partly realized.

These soils will produce fair crops of cowpeas, soja beans, the red, alsike and Mammoth clovers, and among the grasses, timothy, for the growing of which they are specially adapted as well as orchard grass. Corn and wheat yield fair crops, but oats usually do not do so well because the land is wet in the spring and the oats can not be seeded in time to escape the hot, dry weather of July when these soils are just as dry and hot as they are cold and wet in the spring. In many places underdrainage would change conditions very much but a rotation of crops with plants adapted to conditions is the thing to work out in this section for best results. Where the red shale and sand and Potsdam sandstone come together the land is rolling. Some of it is low with deep soils with fairly large water but rather poor fertility-holding capacity, with soils derived from a combination of these rocks making a stony, sandy clay at the foot of the hills, spouty in the spring or during any wet season and the more clayey, hard and cloddy during dry seasons.

Much of this land, though sloping away from the hillside, needs underdrainage of a kind that needs considerable study so as to make these drains as efficient as possible. These soils become very acid and need lime at the rate of from thirty to forty bushels per acre about every six years. When in good crop growing condition,

these soils produce fairly large yields of a hard, red, high-milling quality wheat and fair yields of a splendid quality of corn. They are also fairly good grass soils.

The soils of the Pigeon Hills are derived from the Potsdam sandstone and are comparatively deep with fair water but rather poor fertility-holding capacity. Along the slopes of the hills and on the small rolling upland the land in most sections is stony with stones of such sizes as cannot easily be removed except by blasting or burrying, which is too expensive; therefore these hillsides and uplands should remain in forest for the production of which they are splendidly adapted.

Along the slopes of some of the hills disintegration has proceeded sufficiently to make gravelly soils mixed with some loamy material which produce vigorous disease-resisting apple trees that yield large crops of well-developed, highly-colored, nicely-flavored fruit. These are not only among the best apple and peach soils but the best wheat soils throughout this section, producing fairly large yields of a heavy, high-milling quality, hard, red wheat. A peculiarity of these gravelly soils, especially those that have not been farmed for a very long time is that trees and even farm crops do not seem to suffer for moisture during very dry seasons.

On the rolling uplands where disintegration has made stony loams the soils are deep with large water and fertility-holding capacity, adapted for raising all the regular farm crops, especially wheat, rye, corn, the legumes such as alfalfa, red and Mammoth clovers, the cowpea, the soja bean, the winter vetch, the Canada field pea and crimson clover might be added. From an array of plants like these it is possible to select a sufficient number to successfully carry out the highest principles of agriculture—that of increasing the production of the acre and maintaining and even increasing the productive capacity of the soil.

JACKSON TOWNSHIP

This township lies west of Paradise. The soils of this township are derived from the Mesozoic red shale sandstone and conglomerate, the limestone, the Hydro-mica schists and the Potsdam sandstone. The Potsdam sandstone soils are similar to those of Paradise township except that at the base of the hills facing east and northeast, the sandstone the limestone and the Hydro-mica mix in the formation of the soil, making soils that are deep with large water and fertility-holding capacity, which are usually not spouty, do not need underdraining and are more fertile, needing little or no lime when intensive cultivation is practiced, and are adapted for raising all the regular farm crops. .

The Mesozoic red land is more hilly than in Paradise township because the sandy and conglomerate strata are more prevalent. Along the line of contact between the Mesozoic red and the limestone, the land is moderately rolling and usually fertile, with deep, easily farmed soils, with large water and fertility-holding capacity, adapted for raising all the regular farm crops. In several places along the line of contact the limestone and the conglomerate mix in the formation of the soil, making early, easily farmed soils of splendid fertility, adapted for raising early truck crops as well as the regular farm crops.

Throughout the Hydro-mica formation the land is rolling with well rounded hills with fairly deep soils except along the ridges where the slaty rock usually comes close to the surface, making thin soils with limited water-holding capacity, which wash readily, while along the slopes of these hills as already indicated and throughout the valleys in which the limestone usually crops out the soils are deep with large water and good fertility-holding capacity, well adapted for raising the regular farm crops but with no special farm crop adaptations except (and this has not been fully demonstrated), that the more moderately rolling, where the limestone and Hydro-mica mingle in the formation of the soil, the soils might be specially adapted for raising alfalfa.

These soils need little or no lime, in fact, the writer has seen frequent instances where liming these soils has done harm. These soils, especially the higher elevations and also the gentler slopes can be cultivated early in the spring and will produce early truck crops as well as ripen fall-sown winter crops such as rye and early wheat and fair crops of early oats. Potatoes will, when planted in fields that were well manured on a sod field of the previous summer, produce fairly large crops of mealy potatoes, likely the crop for the production of which these soils have more special adaptations than any other partially regular farming crop.

These soils are specially well adapted for raising small fruits—raspberries, blackberries and more especially strawberries, of which they yield large crops of well-developed, highly-colored, nicely-flavored fruit. These soils have made York county strawberries famous. Two limestone valleys occur in this township, both of which will be discussed in connection with West Manchester township, to which the reader is referred.

HEIDELBERG TOWNSHIP

Now composed of Heidelberg and Penn townships, but here discussed as Heidleberg. This township lies south of Jackson with the Adams county line for its western boundary. The soils of the township are derived from the Potsdam sandstone, the Hydro-micas and

the limestone. Along the line of contact between the Hydro-mica and the Potsdam is quite an area of stony clayey land derived from the Hydro-micas and the finely disintegrated materials from the Potsdam hills, with soils that are wet and need underdraining. These soils when underdrained are among the hard, red wheat soils in this section. They also produce splendid yields of a high quality corn and the clovers, especially the alsike and red. The Potsdam sandstone soils are the same as those discussed in connection with Paradise and Jackson townships.

The Hydro-mica land throughout this township is equally as hilly or even more so than in Jackson township, with a number of valleys, especially along the Codorus Creek and its branches, at such places as Porter's Station along the W. M. Railroad, in which the limestone does not crop out with wet clayey soils that need underdraining and also need lime occasionally.

The Potsdam sandstone or a sandstone, crops out in a number of places in the southern part of the township, making stony land, with fairly deep, stony loams, splendidly adapted for raising apples and peaches, as good a combination as occurs anywhere for raising both these fruits.

The limestone formation coming in from Jackson township pinches out east of Iron Ridge, but a little further west crops out again with here and there a Hydro-mica ridge, all of which completely disappear before Hanover Valley is reached, in which the deep soils with large water and fertility-holding capacities derived from the underlying limestone rock occur, making gently rolling land, the fertility and adaptability of which are not surpassed anywhere in the State. For a fuller discussion of which, see Conewago township, Adams county.

WEST MANCHESTER TOWNSHIP

West Manchester township lies east of Jackson and Dover townships. The soils of the township are derived from the Mesozoic red shale, sandstone, and conglomerate, the Hydro-mica slates and the limestone with a few small seams of trap and limestone combined in the central section.

The soils derived from the red shale sandstone and conglomerate are similar with similar capacities and adaptations as those discussed in connection with Jackson township, except that the area of fertile soils derived from these formations is larger and probably more moderately rolling. The Hydro-mica formation, which begins at the foot of the Pigeon Hills in Jackson township, terminates within the limits of the city of York, only to reappear to the northeast of the city.

The soils derived from this formation are similar with similar capacities and adaptations as those discussed in connection with Jackson township. In the limestone valleys, which unite within the limits of the city of York, the land is moderately and gently rolling, with deep, loamy and clayey soils with larger water and fertility-holding capacity, adapted to the highest developed methods of intensive farming with such crops as are adapted to begin growth in the stormy, and to a certain extent, cold weather of the early spring and ripen during the warm weather of the late spring and early summer and with crops that begin with the warm weather of the late spring and early summer and finish during the hot and sometimes dry weather of mid-summer, and with crops that begin during the hot weather of mid-summer and finish during the cool weather of early and late fall, embracing the entire growing season.

These soils are adapted for raising all the regular farm crops, especially wheat and corn among the cereals, and among the long season legumes, red and alsike clover and alfalfa, and among the hot weather short season, the cowpea and the soja bean, and among the short season cool weather clovers, the Canada field pea and the crimson clover and winter vetch. With an array of plants such as these and with soils adapted for growing then during their respective seasons it is possible to arrange a rotation by means of which advantage can be taken of the entire growing season of the year.

This is one of the dairy sections of the State in which every two acres will, with a crop rotation embracing the entire growing section, produce sufficient grain and roughage to feed a dairy cow for a year.

A white partially crystalized limestone of great purity occurs in a number of places throughout this valley, of which the following analysis by the author gives the composition of an average sample from the quarry.

	Analysis.
Carbonate of lime,	99.08
Carbonate of magnesium,	.34
Silica and sand,	.47
Oxides of iron and alumina,	.08
Total,	99.97

SPRING GARDEN TOWNSHIP

This township lies west of Manchester. The city of York, the county seat of this county is located in this and partly in West Manchester township. The soils of this township are derived from the Hydro-mica, the limestone and the Potsdam sandstone. The Hydro-micas make a hilly country south of York with outcropping

of Potsdam sandstone or a sandstone on Shunk's Hill and other hilltops along the border of the township, with soils especially adapted for raising peaches and apples, for the raising of these fruits these soils should be used. The limestone soils are the same as those of West Manchester township, to which the reader is referred.

Southeast of York, where the N. C. Railroad crosses the Codorus, the Potsdam sandstone terminates in a steep bluff, from which the formation widens until at the Susquehanna River, in Hellam township, it is approximately six miles wide. The soils of this area are quite similar in derivation, adaptation and capacity to the soils of the Pigeon Hills, discussed in connection with Paradise, Jackson and Heidelberg townships, except that the area is larger, the hills not as steep, the upland more rolling, the crests of the hills not as rocky, with deep, stony, gravelly, sandy and loamy soils adapted for raising a hard, red, high-milling quality wheat and a good quality of corn, but especially adapted for raising apples, of which these soil produce vigorous disease-resisting trees that yield large crops of well-developed, highly-colored, nicely-flavored fruit. Along the eastern and western slopes of this ridge are some clay soils similar to those discussed as occurring along the eastern and southern slopes of the Pigeon Hills in Jackson and Heidelberg townships.

HELLAM TOWNSHIP

Hellam township lies east of Spring Garden township, with the Susquehanna River for its eastern boundary. The soils of this township are derived from the Potsdam sandstone, the limestone and the Hydro-mica. The Potsdam sandstone occupies as large, if not a larger area than the Hydro-mica and the limestone put together. Some of this land is moderately rolling, with deep, stony, loamy soils with good water, but rather poor fertility-holding capacity, adapted for raising wheat, corn and rye, and when limed the legumes, such as Mammoth and red clovers and probably alfalfa. These soils will also produce fairly large yields of a fine quality of potatoes. As previously stated they are specially adapted for raising apples. The limestone soils are similar to those previously discussed with similar capacities and adaptations.

The Potsdam sandstone outcrops along the southern border of the township, and together with the Hydro-mica, makes among the best peach soils anywhere in this section, producing vigorous, disease-resisting trees, yielding large crops of well-developed, highly-colored, nicely-flavored fruit. The limestone land becomes more hilly along the eastern border of the valley as the river is approached than it is further west.

The Hydro-mica rock and the Potsdam sand, in some places along this section, rise abruptly from the limestone valley, and make steep hills difficult to farm, in fact, some too steep to be farmed and, therefore, should be planted with forest trees or should be allowed to remain in forest. The Hydro-mica sandy shales, Hydro-micas and slates cover the northern part of West Manheim, Manheim, a narrow strip of Codorus and north Codorus completely with narrow sections along the northern borders of Springfield and York townships. The soils of North Corodus township, with the exception of a few narrow ridges where the sandstone comes to the surface and a few small limestone sections in the valleys, are derived entirely from the Hydro-micas, and with a discussion of its soils, the Hydro-micas may be dismissed.

The townships extend from Heidelberg northeastward along the Limestone Valley, south of Jackson and Manchester, to the junction of the south and west branches of the two Codorus creeks, about three miles southwest of York. The land along the Limestone Valley, south of the Codorus Creek, is, in many places, low and spouty, with loamy and clayey soils derived from the creek deposit, and the Hydro-mica hills, needing underdraining, while immediately south of the lowland, the Hydro-mica hills rise rather abruptly above the plain, as at Spring Grove, making hilly land, with well-rounded hills, with thin soils along the slopes of the steeper hills and comparatively deep soils on the gentler slopes, and the moderately rolling uplands soils with comparatively large water and fertility-holding capacity, not specially adapted, as previously indicated, for raising any one or several crops, but adapted for raising all the regular farm crops, except in the more gently rolling sections which usually occur above the first rise south of the Limestone Valley, where the soils are derived from the brown and grayer, slightly limy shales, and are deep with splendid water and fertility-holding capacity.

Here fairly large crops of hard, red wheat and a good quality of corn, and among the perennials legumes, the red and alsike clovers and alfalfa, and among the annuals, the crimson clover, the cowpea, the soja bean and the winter vetch will produce splendid crops. Alfalfa has not been fully tried out here but seems to do fairly well. These crops can also be raised on the thinner soils of this formation but not as successfully.

In connection with the more gently rolling sections above referred to, sometimes in slightly elevated ridges and again on gentler slopes, occur clayey soils impregnated with white quartz stones varying in size from boulders six feet through, to gravels. These soils, though stony, are clayey and usually wet and cold with a tough clay subsoil and are not by any means as productive as the loamy soils derived

from the shaly rock. These soils need manure and some lime, but manure or even an application of organic matter, such as straw, will increase their production in a short time. The limestone outcrops along the Limestone Valley are usually on the north side of the Co. dorus, except west of Spring Grove, in the northward curve of the creek. A part of the valley is on the south side in this township with similar soils with similar capacities and adaptations as those discussed in connection with West Manchester township.

From the more moderately rolling upland westward, the land is hilly with well-rounded hills, the soils of which wash rather easily and for the protection of which, wherever possible, hillside farming should be practiced.

Seven Valley, south of the more hilly country, begins near the Manheim township line and extends along the southern boundary of the town to the junction of the Codorus creeks, above referred to. In this valley, in a number of places, as in the Hydro-mica section in the York Valley, the limestone crops out and takes part in the formation of the soil, sufficiently so, to make a decided improvement. The sides of this valley are made of rounded hills which, in some places, are steep, in others, rolling, with deep soils, with fairly large water and fertility-holding capacity similar to those previously discussed. On the sandy ridges which occur throughout the central part of the township where the land is not too stony and rough and the slopes too steep, are among the best peach soils anywhere throughout this section, and, wherever possible, these soils should be used for raising this fruit.

WEST MANHEIM TOWNSHIP

The soils of the northern part of West Manheim township, which occupies the southwestern corner of the county, with the Maryland line for its southern border, are derived from the Hydro-micas and are similar in capacity and adaptations to those of North Codorus and, therefore, need no further discussion here.

MANHEIM TOWNSHIP

Lies east of West Manheim, on the Maryland line. The soils of the northern and central part of the township are derived from the Hydro-micas and are similar to those of North Codorus township.

CODORUS TOWNSHIP

This township lies east of Codorus and south of North Codorus, with the Maryland line for its southern boundary. Only a narrow section on the southern side of Seven Valley, with soils derived from the Hydro-micas, previously discussed, occur in this township.

SPRINGFIELD TOWNSHIP

This township lies east of Codorus and south of North Codorus, with only a similarly narrow section of soils of Hydro-mica derivation with similar capacities and adaptations as North Codorus.

YORK TOWNSHIP

York township lies east of Springfield and North Codorus and south of Spring Garden. The soils of Hydro-mica derivation occur mostly in the northwestern part of this township and are among the rolling uplands of this formation referred to in North Codorus township, but are more stony than the soils of the northern section of North Codorus, but equally as fertile, and will produce as large crops as the upland soils of that township will. As previously stated, these soils are well adapted for raising small fruit and early truck crops. A considerable area is at this time used for raising these crops in the Hydro-mica soils throughout the northern part of this township, which are more profitable than the regular farm crops. In the northeastern part of the township are a number of hills, similiar to Shunk's Hill in Spring Garden Township, upon which a sandy rock, together with a Micaceous formation, makes the soils, which are well adapted for raising peaches, of which they produce large yields of fairly well developed, fairly colored and well flavored fruit.

WINDSOR TOWNSHIP

This township lies east of York township and south of Spring Garden, with only narrow Hydro-mica and sandy formations, previously referred to in the discussion of Spring Garden and in York townships, occur adapted for raising the same crops.

A narrow intrusive trap dyke, beginninug in the Limestone Valley, in Spring Garden township, crosses the railroad near Stonybrook with a southern course through the northwestern corner of this township through York and Springfield to the border of Hopewell. In Windsor and Spring Garden townships, this dyke crosses the Hydro-mica formation producing fairly deep stony soils with rather large water and fertility holding capacity, adapted for fruit raising, especially apple of which it produces vigorous trees which yield large crops of well developed, well colored, nicely flavored fruit. In a few small sections this formation and the Potsdam sandstone and the trap, intermingle in the formation of the soils producing soils especcially adapted for raising apples. The regular farm crops also thrive here along this dyke, especially wheat and corn among the cereals, both yielding large crops of splendid quality, and among the clovers, the red and alsike make splendid yields.

LOWER WINDSOR TOWNSHIP

This township lies east of Windsor and south of Hellam, along the Susquehanna River. The soils of the township are derived from the Potsdam sandstone, the limestone, the Hydro-mica and the Chloritic schists. The Potsdam sandstone crops out in a ridge along the northern border, making hilly and stony land, much of it not adapted for farming; and except the more rolling sections should either be planted with fruit such as apples or should be allowed to remain in forest for the growth of which it is splendidly adapted and in the production of which it would yield as large returns as from any other source except probably fruit.

The limestone soils are very similar to the soils of the York Valley. Along the river are some river lands especially adapted for trucking, but equally well adapted for raising crops for feeding the dairy herd. In this township the slaty limestone, some of which occurs along the line of contact between the Hydro-mica and the limestone in Spring Garden and Hellam townships also occur and take part in the formation of the soils producing loamy soils that are comparatively deep, with large water and fertility holding capacity which wherever thorough cultivation is practiced need little or no lime and are splendidly adapted for the production of all agricultural crops.

The Hydro-mica soils occur through the central part of the township and are similiar with similiar capacities and adaptations to those previously discussed. South of the Hydro-mica soils, the soils of the following townships and parts of townships are derived from the Chloritic schist rock, beginning with southern West Manheim along the Maryland line, southern Manheim, nearly the whole of Codorus, nearly all of Springfield, central York, central and northern Windsor and northern and south central Windsor.

The country throughout this formation is more hilly, and in some places, steeply hilly, especially along the smaller streams and on the uplands where the harder gray and quartz containing rock occurs, than the Hydro-mica formation. The land, wherever these rocks occur, is stony and rocky with thin soils, with small water holding capacity adapted more for growing timber than farm crops. Wherever the brown, porous, more easily disintergrated rock of this formation occurs, as it does north of Glen Rock, along the Codorus Creek and eastward, the land is more rolling, the hills well rounded with deep loamy gravelly soils of splendid water and fertility holding capacity; soils that do not wash readily and are adapted for raising all the regular farm crops especially corn and the legumes, such as the red and Mammoth clovers and alfalfa among the long season crops, and among the short season, the cowpea, the soja bean and the crimson clover.

As above stated, the soils derived from the more easily disintegrated red porous rock, are deep with large water and fertility holding capacity, and are especially adapted for raising corn needs a little further amplification. It has been demonstrated by actual yields that during a normal season these deep, and in many places, stony soils produce larger yields of corn than the strong limestone soils of the York Valley, but what is still more surprising, during a dry season with less cultivation these soils will surpass both in yields and in quality of corn the naturally richer limestone soils previously indicated, while during a wet season, these soils will ripen equally as large a crop more perfectly than the limestone soils will.

Beside this more rolling land with soils derived from the more easily disintegrated rock, sections of considerable area of rolling uplands occur throughout this formation with deep soils derived now from the more easily disintegrated rather porous rock and again from the less easily disintegrated grayish green rock, the former making loamy soils and the latter stony loams, with similar water and fertility holding capacity, and equally as productive and adapted for raising as large yields of the same crops as the soils of the rolling land derived from the more easily disintegrated rotten or porous rock of this formation previously discussed.

One of these more rolling upland sections is located in West Manheim township, from whence it extends into Manheim where it forms the upland divide between the tributaries of the several branches of the Codorus Creek. This same divide extends into Codorus township and makes the rolling upland running parallel with Seven Valleys.

In the western central part of Springfield township, and at Loganville in the same township, are two more such sections with similiar soils, with similiar capacities and adaptations. In fact in this section the large yields of corn above referred to have been produced. North, east and south of Loganville the trap rock referred to in the discussion of the Hydro-mica soils comes to the surface and enters into the formation of the soil making soils that are splendidly adapted for apple and peach raising as well as the regular farm crops. Some distance north of Loganville the trap dyke widens, and in a number of places the bowlders lie about the fields and make rough land similiar to the land in the red shale formation north of the limestone valley, except that the soils are more fertile. This same trap dyke extends in a narrow strip through York township, with similiar soils with similiar capacities and adaptations as the soils in the vicinity of Loganville possess.

In the vicinity of Dallastown is another of the more moderately rolling sections, referred to above, with deep soils derived from the more readily disintegrated rock of this formation adapted for raising similiar crops equally successfully. In Windsor township are similiar sections of rolling uplands. On the road from York to Windsor, the Potsdam sandstone, or a sandstone makes a series of ridges with stony land with comparatively deep soils especially adapted for raising peaches and apples. Peach and apple trees make a vigorous growth and yield fairly large crops of well developed, rather nicely colored, well flavored fruit. Strawberries, raspberries, blackberries of all varieties produce a splendid crop of well developed, nicely flavored fruit in even the more hilly and stony soils throughout this formation.

Along the larger streams are rather wide valleys with deep mostly loamy soils adapted especially for raising corn and the hay grasses. On the rolling uplands and the dryer loamy moderately rolling lower lands of the valleys of these streams occur among the best potato soils of this section.

The following analyses of a similiar rock formation may give some idea of the permanent productive capacity of these soils:

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	I	II
Loss by ignition,	6.86%	6.48%
Silicic acid,	48.37 "	50.02 "
Titanic acid,	1.21 "	1.37 "
Phosphoric acid,	0.29 "	0.52 "
Alumina,	14.05 "	17.42 "
Ferric oxide,	5.68 "	6.10 "
Ferrous oxide,	6.50 "	5.98 "
Manganous oxide,	0.91 "	0.29 "
Magnesia,	13.57 "	7.24 "
Lime,	1.03 "	1.04 "
Soda,	0.69 "	0.60 "
Potash,	1.44 "	3.47 "

The following townships in the southeastern part of the county have soils derived from the disintegrated Gneissic and schist rock: Shrewsbury, Hopewell, Chanceford, Lower Chanceford, Fawn and western Peach Bottom. The land throughout this formation is usually steeply hilly along the streams with numerous precipitous rocky outcrops with little or no soil while the soils of the steep hillsides are usually thin, stony and rocky, with little farming land.

The valleys along the streams are narrow, with only rather limited areas of farm land so that the farming land throughout this forma-

tion is about all located on the uplands away from both the valleys of the larger and smaller streams. There are, however, noted exceptions to this statement which will be referred to later.

SHREWSBURY TOWNSHIP

This township lies east of Codorus, south of Springfield on the Mason and Dixon's Line. The land of this township, as previously indicated, is hilly along the streams and moderately rolling on the uplands, with deep, loamy, and wherever the less easily disintegrated rock exists stony loams with large water and fertility-holding capacity. Two of these rolling upland sections occur east and west of New Freedom and in the vicinity of Shrewsbury, one of the oldest towns in this township, with the deep soils in which, at this time, the agencies of disintegration are operative and are putting new soil material into finely divided condition so that the agencies of solution can more readily convert this material into soluble condition ready for the use of the plant.

With soils of this derivation, in which the agencies of disintegration are going on, as previously stated, the farmer should keep the cultivated surface in such condition as to facilitate this operation in so far as possible, which can be done in these soils by keeping up the supply of organic matter. What has been stated here with regard to the soils derived from this formation is largely true of the Chloritic and the Hydro-mica soils.

At New Freedom occurs one of the wider valleys in this formation, at the head waters of one of the branches of the Codorus Creek, surrounded on the south and east by low, moderately rolling land, with deep, warm, early spring farming soils, with large water and fertility-holding capacity, probably better adapted for raising such crops as can be started in the previous fall and be ripened early in the following summer, or for early spring seeding crops which can be harvested in mid-summer, and for crops started in the late spring which ripen in the early fall and for crops seeded in mid-summer which ripen in mid or late fall, as well as for crops as previously indicated that can be seeded in the late fall and harvested the following spring and in this way take advantage of the entire growing season. As stated under the discussion of the Chloritic soils, so these soils are among the best, if not the best, corn soils in this or any other section of the State. All the legumes find congenial soil environment here, especially alfalfa. From three to six tons of alfalfa hay have been raised in the vicinity of Stewartstown, where another of the rolling upland sections of these soils occurs.

The soja bean, the cowpea and the crimson clover, as well as the red alsike and Mammoth clovers, all find congenial soil conditions, not only on these rolling uplands but on the more steeply hilly sections, along the smaller as well as the larger streams. Wheat yields large crops of a fairly hard, red, good-milling quality. With such an array of crops of both the soil-exhausting and the soil-improving types a rotation can be worked out for raising the largest amount of human nutrition and for maintaining the fertility of the land.

HOPEWELL TOWNSHIP

This township lies east of Shrewsbury and south and east of Springfield. The soils are similar in derivation and adaptation and capacity to those of Shrewsbury. Among the rolling upland sections, one occurs at Winterstown, and thence north and northeastward as well as southeastward to Cross Roads, southward to and beyond Stewartstown, with deep, easily-farmed, early spring crop soils with splendid water and fertility-holding capacity, adapted for raising the same crops as those discussed under Shrewsbury township.

CHANCEFORD TOWNSHIP

This township lies east of Hopewell and southeast of Windsor and Lower Windsor, with the Susquehanna River for its eastern boundary. The soils of the township are derived from the same rock formation as those of Hopewell, with similar adaptations and capacities.

The rolling uplands are comparatively more extensive, beginning as they do in Windsor and Lower Windsor townships and extending in the former township from Windsor to Brogueville and eastward nearly to the river, and in the latter, from north of New Bridgeville to the same upland section which extends from Brogueville in this township toward the river and these united uplands extending from Brogueville into Lower Chanceford township. West of Brogueville, along one of the smaller streams, is one of the valleys previously referred to, as existing in various sections throughout this formation, with moderately sloping hills enclosing it, with soils of splendid fertility adapted to the highest type of intensive farming.

LOWER CHANCEFORD TOWNSHIP

This township lies southeast of Chanceford, with the Susquehanna River for its eastern boundary. The rolling upland in the northern part of this township remain as extensive as in Chanceford; but at Centreville the more hilly land along the Muddy Creek and the river encroach and the rolling upland narrows until in southern Lower

Chanceford, these rolling uplands are limited to the ridges between the numerous streams but are equally as fertile as the more extensive areas with similar capacities and adaptations.

FAWN TOWNSHIP

Fawn township lies west of Lower Chanceford and south and east of Hopewell. This township and western Peach Bottom are virtually composed of a series of these upland sections, the more extensive between the south branch of Muddy Creek on the west and several smaller streams flowing northeastward into Muddy Creek near the eastern border of the township extending from Gatchelville southward to Fawn Grove, and another extending from Stewartstown in Hopewell township, southeastward to Fawn Grove, and from Fawn Grove northward to Bryantsville in Peach Bottom township, at the juncture of the Peach Bottom slate formation.

The raising of the crops suggested for southeastern Pennsylvania, as well as other sections of the State with similar climatic and soil conditions advocated throughout the bulletin, have been practiced in this township.

Alfalfa has been raised for the past ten years at the rate of from four to six tons of hay per acre. Soja beans, the cowpea, the winter vetch and crimson clover have all been and are at this time being successfully grown on the moderately rolling uplands of this and surrounding townships. Corn breeding of the best developed type has been practiced in this township for a number of years and its benefits fully demonstrated so that what has been said about the raising of these plants need not be verified.

PEACH BOTTOM TOWNSHIP

Peach Bottom township occupies the southeastern corner of York county. The land east and west of the Peach Bottom slate ridge is very similar to the land previously discussed, with equally deep large water and fertility-holding soils adapted for raising similar crops equally as well.

ADAMS COUNTY

Adams county was erected from part of York county by Act of Assembly, January 22, 1800. It contains 337,920 acres, of which 281,858 is land in farms, and of which, 227,684 is improved farm land. 44,231 acres were planted with corn in 1909, yielding 1,357,270 bushels; 14,945 acres were sown with oats, yielding 403,224 bushels; 50,180 acres with wheat, yielding 874,846 bushels; 56 acres with

buckwheat, yielding 713 bushels; 7,617 acres with rye, yielding 109,403 bushels; 2,207 acres planted with potatoes, yielding 170,507 bushels; 23 acres with tobacco, yielding 25,944 pounds; 53,891 acres sown with all forage crops, yielding 60,663 tons of the various kinds of hay. Of the 227,684 acres of improved farm land, 173,149 were used for raising farm crops, while 54,535 were not so used and were likely producing weeds. At this time Adams county had a population of 34,319 people to feed, 24,177 cattle, 9,978 horses, 2,775 mules, 22,008 swine, 7,122 sheep.

Adams county lies west of York, east of Franklin, south of Cumberland counties and has the Maryland line for its southern boundary. The geological formations from which the soils of the county are derived are the sandstone and shales of Mesozoic Age which are the source of the largest soil area of the county. The intrusive trap, composed largely of Syenite, forms the basis of another considerable soil area, while the Gneissic and Potsdam sandstone and conglomerate form the south mountain section, with a considerable area of Potsdam in the Pigeon Hills, while the Silurio Cambrian limestone, largely confined to the southeastern part of the county, is the basis of the soils in that section with a limited area of Chloritic and Mica schists in the southeastern corner.

UNION TOWNSHIP

This township occupies the southeastern corner of the county, with the York county line for its eastern and the Maryland line for its southern boundary. The soils of the township are derived from the disintegrated rock of the Mica and Chloritic schist. The land usually is moderately rolling with here and there hilly sections. The soils on the small ridges and isolated knobs, of which there are a considerable number, are stony because these hills are formed of the less easily disintegrated rocks of this formation. Some of this land is so stony that it is difficult to farm, but the breaking up process of the rock on the tops and sides of these hills and ridges has penetrated the underlying rock in many places to a depth of several feet and the spaces between the broken rock have been filled with finely disintegrated rock and organic matter and a soil has been made that, with little cultivation, will produce fair crops of rye, wheat and corn, especially rye and corn. These soils do not wash readily, especially if the organic matter is continuously supplied. But the crops these soils are best adapted for are the stone fruits, peaches, apricots and plums. Apple trees thrive well here and so do small fruits, and it seems that a combination of apricots, peaches, plums and small fruits and apples on these soils could be made an inviting business because markets that will consume these fruits are within easy reach.

On some of the hills the underlying rock has resisted this breaking up process, and consequently the soils are thin, wash readily and have small water and fertility-holding capacity and should be turned into woodland. On the more moderately and gently rolling areas, the soils are not stony enough to interfere with farming operations, but are deep with large water and fertility-holding capacity, are easily farmed and with comparatively little cultivation can be put into splendid condition for seeding or planting crops. These soils are best adapted for raising the regular agricultural crops, the hay grasses and among the cereals, rye, corn and wheat.

A type of clay soils with a considerable mixture of white quartz occurs in small sections throughout this formation. The size of the quartz particles vary from sand grains to rounded boulders of three or four feet in diameter, whatever the sizes of the quartz material may be the clay is mixed with it and acts as a sort of cementing material that holds the sandy particles together and makes a tough soil when wet, and a hard and cloddy soil when dry. This is the most unproductive and most difficult to farm soil of this formation. This land has a voracious appetite for manure, which is the only amending material that seems to awaken its dormant productive capacity, and if frequently applied this soil will produce paying returns. On all of the various soils of this formation, in this section, a crop of cowpeas can be raised after a crop of rye or wheat has been harvested and these plowed down and the land prepared and seeded with wheat or rye and then seeded with grass. Such an operation will wonderfully increase the productive capacity of these soils. The northwestern part of this township lies in the limestone formation and will be discussed in connection with Conewago and Oxford townships.

CONEWAGO TOWNSHIP

This township lies entirely within the Silurio Cambrian limestone formation with soils derived from these strata. The land is gently rolling, with sections that are flat and boggy, with clay soils that are too wet to begin farming operations sufficiently early in the spring to produce crops such as these soils are capable of yielding, and which they do produce when the rainfall is limited so that they can be prepared and the crops put in early. To facilitate early planting and to prevent drowning out crops, these soils need underdrainage to put them into a condition to attain their maximum yielding capacity. In many places these lowlands embrace several farms or parts of farms and cover a considerable acreage and for this reason probably a township or county system of drainage should be established here. The gently and moderately rolling land of this

Conewago Valley is among the most fertile and productive in the State, with deep, easily-farmed soils, adapted to the raising of all agricultural crops and to the highest type of intensive farming.

Climatic conditions are such in this section of Adams county that a normal corn growing season of from 120-130 days prevails, and, therefore, with a corn stalk developed to such a degree of efficiency that it will produce the longest ear with the largest number of rows of grains, five-eighth of an inch long that can be ripened in a normal 120-130 day season should be the aim of the progressive farmer to grow in this valley. This would mean in this type of soil from 10-20 bushels more shelled corn to the acre than a 90-100 day corn would yield. In this section two crops of roughage can be raised in the normal year, a summer crop of silage corn followed by a fall and spring crop of rye and Russian or winter vetch or a crop of soja beans followed with a crop of rye and vetch which can be harvested for hay or plowed under for fertility. The crops now raised throughout this valley are corn, some oats, wheat and the hay grasses. Alfalfa yields large crops, on the moderately rolling land, wherever it has been sown with the care necessary to get the crop started. Southern Oxford, eastern Mount Pleasant, and northern Germany townships lie within this valley with soils of similar structure, adaptation and capacity.

BERWICK TOWNSHIP

This township lies east of Oxford township on the York county line. The soils are derived from the disintegrated Potsdam sandstone and conglomerate in the southern part, and from the more easily disintegrated red shale of Mesozoic Age in the northern part of the township. Throughout the south-central part of the township this sandy formation has yielded to the agencies of disintegration to such an extent that in many places moderately rolling clay soils have been formed with good crop yielding, water and fertility-holding capacity. In some small level sections this soil has become soggy and wet, and where this condition exists the land is of little value for farming unless underdrained, but when underdrained produces well, especially the hay grasses and when lime is supplied, wheat and the clovers, in fact all agricultural crops. The rolling and less hilly land of these clay soils is adapted for raising the regular agricultural crops and will, when well supplied with manure and a certain amount of phosphoric acid, yield inviting returns. Where the limestone and the sandstone combine in the formation of the soil along the western border of the township, where disintegration has proceeded sufficiently some deep somewhat cherty soils occur, of splendid productive capacity.

The more cherty of these soils are among the best apple soils in the southeastern section of the State. Along the southern border of the township similar formations with similar adaptations occur, but the soil does not seem as fertile. Along the border between the Potsdam and the red shale formation occur several stony ridges with soils that are too stony to be profitably farmed but adapted for forest growth or the less stony for raising peaches. The transition from the more stony and rougher Potsdam formation of the soils into the red shale is quite sudden in many places and the topography changes from a hilly to at least a moderately rolling or even gently rolling topography within short distances. The soil in the northern section of this township as well as that of the following townships and parts of townships is derived from the more easily disintegrated shaly and sandy strata of Mesozoic Age.

Eastern Reading, nearly the whole of Hamilton, northern and western Oxford, eastern Mount Pleasant, western Union, eastern Mount Joy and a small part of western Germany. Only a small section of eastern Reading township lies within this formation and therefore what is said of the soils of Hamilton township is equally true of those of Reading.

HAMILTON TOWNSHIP

This township lies north of Berwick and Oxford with the York county line for its eastern boundary. As already indicated, the soils of this township are derived from the more easily disintegrated strata of the shales and sandstones of the Mesozoic Age. The soils, with the exception of some sandy ridges such as occur along the banks of the Conewago Creek northwest and north of East Berlin, are gently rolling and comparatively deep, ranging from eighteen inches to a number of feet, the deeper having good water and fertility-holding capacity, are easily farmed and where well tilled, produce satisfactorily the regular farm crops, while the more shaly and underlaid with sandy strata have so limited a water-holding capacity that in only a medium dry season crop yields are materially reduced on account of not having a sufficient water supply. These areas are not extensive but usually nearly every farm contains a small section. These shallower soils will usually produce a crop of timothy hay, rye and some seasons, wheat, because the timothy and the rye get far enough ahead, unless the spring season is dry, not to be materially effected by the usual dryer weather of the middle and latter part of June and will, therefore, return larger yields than the summer crops such as corn and oats.

Red and alsike clovers yield fair crops but the soil is so deficient in organic matter that these crops do not yield as they would if this material would be supplied. This organic matter could be supplied

by the application of manure and by raising a crop of cowpeas after harvesting a crop of rye. The rye could, in a normal season, be gotten off the ground by the first to the tenth of July, the land disked harrowed and the cowpeas sown with the grain drill, at the rate of a bushel to the acre. The peas, if not too rank, could be cut up with a disk harrow early in September and thoroughly mixed with the soil and the land seeded with rye or wheat and timothy or timothy and red clover, the grass sod plowed after the second crop of hay was harvested and seeded with cowpeas, the cowpeas disked as previously suggested and seeded with rye and timothy. By this operation a money crop could be raised on these sandy soils every year, and if in addition to the cowpeas some manure is applied on the timothy sod, these crops will yield paying returns. The deep soils derived from the more shaly and readily disintegrated strata of this formation are adapted to raising all the regular farm crops and should be used for this purpose. The soils underlaid with the sandy strata have a wonderful hunger for organic matter, and when this is supplied in any thing like sufficient quantity, the yield of crops is increased as much as fifty per cent. The barn manures should be applied to this soil directly from the stable because they have the capacity of working up the rawest kind of organic matter in a short time and making its fertility available. This capacity for getting the fertility out of organic matter in a short time should be taken advantage of in crop production and such crops should be raised and such a rotation adopted that will furnish the largest quantity of a high type of this organic matter together with a large amount of animal nutrition, the nutritive part taken out of the crop and the unavailable part for nutrition together with the waste matter from the animal returned to these soils at once and by them worked over again into crops. Along the streams throughout these townships, especially in the curves of the Conewago, at such places as East Berlin and south of Oxford are sections of very fertile soil adapted to the same intensive farming as the soils of the limestone valley previously discussed.

What has been said in the discussion of Hamilton township applies equally to the soils of Tyrone township between New Chester and Heidlersburg and to Oxford township lying south of Hamilton derived from these strata, and to the soils of Mount Pleasant lying southwest of Oxford and to those of Mount Joy and Union lying south of Mount Pleasant, and to Germany lying south of Mount Joy and Union on the Maryland line. In Germany township, southwest of Littlestown, is a section of sandy soils well adapted to raising peaches and early truck crops as well as potatoes. Westward from this, more easily disintegrated shale, the underlying rock is more sandy and consequently disintegration has not proceeded to the same

depth and to as high a degree of perfection as the rock previously discussed. This formation comes in from York county and covers the eastern part of Reading township and continues southwestward, approximately paralleling the previously discussed, more easily disintegrated red shale. At Hampton and for some distance southward, the formation is narrowed because of the more readily disintegrated shales prevailing. Further southwestward it widens until on the Maryland line it is five or more miles wide.

The following townships and parts of townships east of the dyke which passes through the county, have soils derived from the underlying strata of this formation, eastern Reading, eastern Tyrone, eastern Straban, western Mount Pleasant, and about the whole of Mount Joy. West of the Granitic dyke which passes through the county in a southwestward course, the soils of the following townships and parts of townships are derived from the more sandy strata of the Mesozoic Age. Eastern Latimore and Huntingdon, central Tyrone, nearly the whole of Butler, all of Straban west of the Granitic formation, above referred to, eastern Franklin, all of Cumberland west of the Granitic dyke, eastern Highland, central Freedom and eastern Liberty. This is the most extensive underlying rock formation of the county and the largest area of soils is derived from these strata extending, with the exception of the granitic dyke above referred to, from the previously discussed soil formation to the base of the South Mountain.

This entire formation is moderately rolling, some even gently rolling, with smaller sections that are flat. In many places along the streams the banks slope steeply, some even being precipitous, while in the curves of the streams the land is as fertile and adapted to the same intensive farming as that previously discussed. Wherever the precipitous banks occur, the finer soil particles have usually been washed away as fast as they were made and consequently the land is stony or the bare rock remains on the surface, making sections that are too stony and rocky for raising agricultural plants. On some of the rolling land away from the streams, along the rounded hillsides where washing away of the soil has taken place, the land is stony, the soil thin, revealing the resisting capacity of the underlying rock to the agencies of disintegration; usually these areas are not extensive. This resisting power to the agencies of disintegration and the consequent formation of thin soils on the comparatively level uplands where the soil could not have been washed away or washed away very slowly and on the gently rolling lowlands because generally in both cases, the soil becomes so water-logged from the rains of a normal spring that winter crops such as wheat and the hay grasses can not make an early start and farming operations are delayed, that spring crops cannot be started sufficiently

early to escape the effects of only a normally dry season in July, and both winter and spring crops are held up in the beginning and curtailed in the ending by only the normal delay of rain, and crop yields are not what they would be if the rainfall would come just when these crops needed it, showing that crop yields are because of the impervious-to-water and resistance-to-disintegrating-agencies of the underlying strata, curtailed very much by too much and not enough rain. Underdraining, will in part, mitigate the evil of too much rain, but will do little or nothing when there is not enough rainfall except that the drains will keep a supply of air in the soil which is very essential. An adequate supply of organic matter to hold a sufficient quantity of water in a capillary condition to tide the crops over a normally dry season and to hold a sufficient quantity of excess water in a wet season, to make the soil dry enough for winter crops to make an earlier start and to put the soil into condition for farming operation, to begin earlier, will increase the productive capacity of these soils fifty per cent. The low and approximately level and gently rolling land of this formation produces large crops of timothy hay and when well farmed very creditable crops of corn, wheat, oats and clover, especially the alsike clover. The higher land produces timothy hay. Large crops of rye and buckwheat and from the few demonstrations that have come under the writer's observations would produce large crops of cowpeas after this plant had been accommodated to this soil. The soja or soy bean will also thrive on the gently and moderately rolling of these soils and so will the Russian or winter vetch and the crimson clover. With such an array of crops, especially clovers, that can be raised on these soils a rotation can be worked out that will furnish the organic matter for which these soils have such a hunger and will increase the yield of the acre and the producing capacity of the land wonderfully. This rotation should be so arranged that a clover will follow each of the grass and cereal crops similar to that suggested for the more sandy sections of the previously discussed soils.

What has been said here applies to the various townships above enumerated. Two intrusive trap dykes come into this county from York county and pass through the townships previously enumerated, in a southwestern course into Maryland. Along the sides and at considerable distances away from this dyke where the intrusive rock has not come to the surface, the rock of the Mesozoic Age, which overlies it, has been changed by the heat of this igneous intrusive rock so that the soils derived from it are some blue and others grey in color with productive capacities that vary very much with topography. The moderately rolling, loamy gravel soils derived from this rock are among the best wheat soils in the county, producing large

yields of a hard, red wheat of superior milling quality. Some of these farms might with profit be used for raising seed wheat. They also produce large crops of corn and the clovers. These soils have large water-holding capacity, can be worked early in the spring, giving both summer and winter crops an early start and do not dry out readily in hot and dry weather. Most of the lowland of this formation has clay soils which if underdrained will produce equally large crops of superior wheat, but unless drained, the soil is difficult to manage and not productive.

The soils of the trap dyke, already referred to, derived from the disintegration of the Syenitic rock which forms nearly all of it are clay loams on the lowlands and gravelly and some stony loams on the more rolling formations, while the higher and steeper hills are rocky with little or no soils suited for raising agricultural plants. The two Round Tops on the Battlefield of Gettysburg are typical illustrations of the rocky land, while the soil of the Wheatfield between Little Round Top and Devil's Den is typical of the clay loams and the clays. Southwest of the Round Tops is a section of clays that well illustrates the character of the clay soil more extensively. Much of this land is wet with a tough clay soil difficult to farm but when well drained soon becomes easily farmed and productive.

The more rolling land of this formation has some splendid farming sections that will produce inviting yields of all the agricultural crops as well as fruits, especially peaches, apples, grapes, plums and also the small fruits. Wherever a tree is planted in this soil or among the rocks of the rocky formation it will grow and produce fruit. The best use that can be made of this rough land is either to plant it with fruit trees or allow it to grow forest trees, which it will do naturally. Typical illustrations of the rolling, easily-farmed land with deep gravelly loams and loamy soils with splendid water-holding capacity, adapted for raising agricultural crops, more especially wheat and corn and the clovers, occur southeast of Gettysburg as well as many other sections throughout the northeastern and southwestern course of this dyke through the country. Besides this strip of trap outcrop extending in a well nigh straight line through the eastern central part of the county a considerable area of soils derived from this rock occurs south and east of Fairfield, in Highland, Freedom and Liberty townships and north and south of Arendtsville in Butler and Franklin townships, and from Center Mills northeastward and northward in Tyrone, Huntingdon and Latimore townships. Throughout this central western section of the county the rock of the trap dyke commingles in the formation of the soils, beside the Mesozoic strata, with the Potsdam sandstone and the Gneissic rock, making the soils derived from this mixture different in structure and adaptation.

Through the central part of Latimore township the Gneissic and trap rock comes to the surface immediately west of the more easily disintegrated Mesozoic strata. The land is moderately rolling with deep, loamy soils easily farmed, with large water-holding capacity, adapted to raising all the regular farm crops, especially corn, wheat, clovers, potatoes and also early market crops, but the crops, for the raising of which it seems these soils, both the moderately rolling, loamy as well as the small areas of hilly and stony types, have special adaptations, are apples and peaches. These soils produce larger yields of highly colored, nicely flavored peaches than can be raised on any other soils in the State. Apples, such varieties as the Stamen Winesap, Grimes Golden, the King and the York Imperial and many others also yield large crops of a highly colored, nicely flavored fruit. In the western part of Latimore township—which occupies the northernmost part of the county—the soils are derived from the Potsdam sandstone and the Gneissic rock. The land is some moderately rolling and other sections hilly, with some steep, stony declines but usually deep soils with such water-holding capacities that will usually carry farm crops through a normally dry season.

These soils will produce the regular farm crops, but apples will yield many times larger returns than the regular farm crops, and a fruit that can not be surpassed on any soils but those derived from the Potsdam, Gneissic and Syenitic rock in the southeastern part of the State for color and flavor. With these peculiar natural adaptations, it seems that these soils which up to this time have produced highly colored and nicely flavored fruit without any soil amendments in the way of artificial fertilizer, should be used for this purpose in connection with the production of such crops as experience will demonstrate are best adapted to keep up or enhance the fruit producing capacity of these soils permanently. North of Idaville in Huntingdon township the Potsdam sand and conglomerate and the Gneissic rock form the soils similar to those described in Latimore township with similar adaptations. From Idaville southeastward to, and beyond Heidlersburg and eastward toward York Springs are some areas of clay loams, and the gravelly loams as well as the stony and rocky types of soils derived from the outcrop with similar adaptations to those already discussed in connection with the trap dyke extending through the eastern central section of the county. Where the Gneissic and the Syenitic rock unite in the formation of the soil throughout this section peach and apple soils of similar capacity as those referred to in Latimore township occur. In the vicinity of York Springs, the Silurio Cambrian limestone outcrops and is sufficiently pure to make lime for building and agricultural purposes; it also takes part in a few sections in the formation of the soil with its usual salient effects. From Idaville southwest-

ward to Bendersville in Menallen township are a number of smaller areas in which the Syenitic, the Gneissic and the Potsdam sand and the conglomerate rock have taken part in the formation of the soil upon which a forest, where the woodman's axe has not interfered, of such density is growing, that the struggle is one for sunlight instead of fertility, demonstrating what has been previously asserted, that this is a fruit tree and forest soil. Southeastward from Bendersville to Center Mills are small areas of soils derived from the Syenitic and the combined Syenitic and Gneissic and also the Syenitic and easily-disintegrated Mesozoic rock, the crop adaptations of which have previously been described. From Bendersville southwestward through Menallen, northwestern Butler into Franklin township the Gneissic, the Potsdam sand and the conglomerate continue being the basis from which the soils are derived, except a small area beginning southwest of Floradale where the Syenitic rock crops out and forms a section of soils similar to those previously described.

Throughout this whole section wherever the soils derived from the Syenitic and the Gneissic with some additions of Mesozoic rock exist the highly-colored, nicely-flavored peaches can be grown, and wherever the Potsdam sand and conglomerate and the Gneissic rock forms the soil, the highly-colored and nicely-flavored apples are being raised. Both apples and peaches yield spelndid crops of superior fruit on each of these soil types. Between Biglersville and Arendtsville a considerable acreage of apple orchards has been planted on the more easily disintegrated red sandy shales of the Mesozoic formation, which are producing well. The same Syenitic outcrop with the same types of soils with similar adaptations, which begins southwest of Floradale, continues in the same direction into Franklin township northwest of Arendtsville, where it widens as it extends southwestward until the western extremity reaches Hilltown and the eastern comes within a mile of Mummasburg. Much of this land is hilly, some stony and rocky and difficult to farm, but with care can be made to produce fruit of a superior type and should be used for this purpose. In the vicinity of Hilltown and Cashtown and for some distance southward an impure limestone of the Silurio Cambrian formation crops, out, and form the basis of a small but fertile section of gravelly soils that will produce large yields of the regular farm crops, but is especially adapted for raising a hard, red wheat, corn, clovers and in some instances potatoes also yield large crops. This land should be farmed so that a large acreage could be devoted to raising a highly developed and pure type of seed wheat and clover seed. A rotation by means of which this could be done, would be wheat followed with clover, of which the first cutting could be made into hay and the second crop cut for seed and the sod plowed under and the land planted with potatoes. Some grain feed

would have to be purchased to feed the animals with such a farming operation. Small areas of soils derived from this limestone occur east, southeast and south of Fairfield. In the vicinity of Cashtown and Hilltown, the limestone and the easily disintegrated red shale and sandstone commingle in the formation of the soil. This makes a good fruit soil. Around the small area of soil derived from these strata east of Fairfield the Gneissic, the Syenitic and the limestone join in its formation and produce small areas of peculiarly fertile land, the capacity of which, because of its composition, should be investigated. The same limestone soil formation continues southward from Cashtown in a comparatively narrow strip until, in the vicinity of Fairfield in Hamilton township, it extends into a beautiful gently-rolling valley known as Carroll's Tract, with soils adapted to as high a degree of intensive farming as the limestone soils of the Conewago Valley, in the eastern part of this county previously discussed. Some of the more level sections of this valley need underdrainage to realize the full capacity of these soils. Along the west side of this valley where the limestone, the Potsdam sand and conglomerate and the Gneissic rock enter into the composition of the soil, the land is hilly and some of it rough and stony, but whether hilly, rough, stony or loamy the soils are usually deep, with good water-holding capacity and well adapted for raising the regular farm crops, but more especially wheat, corn and the clovers.

Personally the writer believes that as large an acreage of these soils as can be handled on these farms should be devoted to raising seed wheat and clover seed, together with such other crops as will give satisfactory monetary returns and maintain the fertility of the soil. South of the limestone soils, along Tom's Creek and east of this stream in Liberty township, the rock from which the soils are derived embrace the Mesozoic sandstone and shales, the Potsdam sand and conglomerate, the Gneissic and for a short distance north of the Maryland line the narrow strip of soils derived from the same limestone as those in the vicinity of Fairfield.

Western Liberty, western Hamilton, central and western Franklin and central and western Menallen townships lie in the South Mountain section of Adams county, with soils the more moderately rolling of which are derived largely from the more easily disintegrated Gneissic, Potsdam sandstone and conglomerate. These soils are stony and gravelly loams, in connection with small areas of clays usually deep with sufficient loam to give them fair water and fertility-holding capacity, so that the stony and gravelly loams will produce fair averages of the regular farm crops, while the clayey soils known as the copper stone land, usually located along the lower slopes of the mountain, will produce, when well farmed, as large yields of the regular farm crops as the limestone soils of the rich

valleys of the county and are equally well adapted to intensive farming. The crop from which the largest yields can be obtained on these soils are apples and peaches and about all of them but the so-called copper stone soils should be devoted to producing these crops, and if a market can not be reached to consume the fruit as it ripens, cooperative canning factories should be built here and the fruit canned and marketed when the market demands it.

FRANKLIN TOWNSHIP

Franklin township contains a large area of the more moderately rolling of these soils, a large area of rough, rocky and stony land, with soils derived from the Potsdam quartzite sandstone and conglomerate which does not yield readily to disintegrating agencies, and also exists in western Hamilton township, which is not adapted for raising agricultural crops, some of which is available for raising fruit, but the greatest part should be kept in forest, for which it is admirably adapted. In western Franklin and northwestern Menallen is another such section with similar adaptations. A large area of this land is owned by the State and is being reforested. The Big Flat, part of which is located in this county, will be discussed in connection with Cumberland and Franklin counties.

DRAINAGE

The drainage of the county is accomplished by the Conewago Creek, which rises in the northwestern part of the county and flows eastward into York county, and into the Susquehanna River, draining the northern and northwestern section. Some distance east of New Chester, the Little Conewago, which rises in the southeastern corner of the county, draining that section, empties into the Big Conewago. A narrow divide beginning southwest of Hilltown in Franklin township, extending through Hilltown thence eastward and southeast through eastern Germany township, separates the water flowing into the Susquehanna, through the Big and Little Conewago and that flowing into the Potomac River through Tom's Creek, Marsh Creek, Rock Creek and Alloway Creek, all of these draining the central and southern sections of the county west of Germany township.

Adams county has a large area of the natural fruit soils which extends westward into eastern Franklin and Cumberland and thence northeastward through York, Lebanon, Lancaster, Berks, Chester, Lehigh, Montgomery, Northampton and Bucks counties, making the largest, by nature, well adapted peach territory in the State. This area extending throughout these counties, has not only the soil but the essential climatic conditions, such as freedom from late frost, but usually sufficiently cool weather to hold back bud development

until the normal season of late frosts is passed, enough sunlight to produce high color and good quality and yet not too high a temperature to injure fruit. A long, cool fall to ripen the wood and sufficient humidity in the air to prevent abnormally low temperatures so that the moisture in the wood is not changed. A larger area of this land should be devoted to raising this, the most luscious fruit of the Northern States, in this and the counties northeastward.

FRANKLIN COUNTY

Franklin county was named "Franklin," in honor of Benjamin Franklin, in 1784, at which time it was separated from Cumberland county, but as early as 1728-40 agricultural operations had developed sufficiently to erect grist mills.

It contains 480,640 acres, of which 385,334 acres is land in farms, and of which 295,560 acres is improved farm land. 56,998 acres were planted in corn in 1909, yielding 1,446,845 bushels; 8,524 acres were sown in oats, yielding 208,984 bushels; 77,610 acres were sown in buckwheat, yielding 1,239 bushels; 9,187 acres were sown in rye, yielding 124,380 bushels; 3,211 acres were planted with potatoes, yielding 18,345 bushels; 65,038 acres were sown with all forage crops, yielding 75,534 tons of the various kinds of hay. At this time Franklin county had a population of 59,775 to feed, 29,584 cattle, 16,050 horses, 1,117 mules, 34,222 swine, and 21,007 sheep.

Franklin county lies west of Adams and southwest of Cumberland counties, on the Maryland line. The underlying rock and strata from which the soils of this county are derived begin with the Azoic shists and the Potsdam sandstone and conglomerate and extends through the Silurio Cambrian limestone, the Utica and Hudson River slates and shales, the Oneida and Medina sandstone, the Clinton red shale, the Lewistown or Lower Helderberg limestone, the Oriskany sandstone, with a small section in the southwestern corner of Marcellus and Hamilton strata.

Eastern Washington, eastern Quincy, eastern Guilford, eastern Greene, eastern Southampton townships, occupying the southeastern and eastern part of the county, have soils derived from the Micaceous shists and the Potsdam sand formations. The southeastern corner of Washington township is steeply hilly along the streams; but on the upland the land is not too rough or hilly for farming, as is the case east of Pen Mar and on the hills throughout this section, where some farming is done. Peach trees thrive on the more gravelly and stony of these soils and produce a well-flavored and nicely-colored,

good sized fruit. Apple trees seem to thrive better in these soils and make a more vigorous, healthy and disease-resisting growth and therefore wherever possible, this land should be used for raising apples.

Further northward in this township and on into Guilford, the land is rough and hilly with soils largely derived from the Potsdam sandstone, especially in the eastern part, adapted to growing forest trees, to which about all of it should be devoted. Eastern Greene and eastern Southampton have similarly rough land with some sections on the highland, from which the streams rise, of moderately rolling land which is being farmed. Apples will yield better returns in this land than any crop that can be raised, except where the land is low and sometimes wet, the grasses will thrive better than any other crop. West of this rough and hilly country along the lower slopes of the hills and mountains, the soils are derived from the debris that came from the hills and mountains composed of the Potsdam and so-called "Iron Stone" and Gneissic rock, producing quite an area of soils in Guilford and Quincy townships, of splendid productive capacity, adapted especially to apple growing. Apple trees seem to find this a specially congenial soil because they make such a vigorous, disease-resisting growth and produce well nigh annually large yields of a well-developed, high-colored, nicely-flavored fruit. These soils are deep, with sufficient water-holding capacity to develop a crop of apples unless the season is abnormally dry, and with such fertility that artificial fertilization has shown no benefits up to this time. Peach trees also find congenial soil and climatic conditions and produce large crops of well-developed, nicely-colored, well-flavored fruit.

West of this along the foot of the mountain where the soils are derived from the mountain rock, and the limestone outcrops which, together with the mountain rock enters the formation of the soil, producing soils, though hilly and sometimes rough, with many oval-shaped formations of fallen-in sink holes, of splendid fertility and equal in producing capacity to the soils of the Limestone Valley. These soils will produce large crops of a high-milling quality hard, [illegible] wheat, as well as large crops of potatoes and clovers and are therefore adapted for a rotation of wheat, clovers and potatoes. A splendid combination, both financially for the farmer and for the improvement of the soil, if manure and some commercial fertilizer composed of phosphoric acid and potash is applied. A considerable area of these soils are planted with apples and peaches, more apples than peaches. The trees are thrifty and bear large crops of well developed, nicely-colored and flavored peaches and apples, but both peach and apple trees are not as vigorous and do not seem to have

the disease-resisting capacity that these same varieties of peach and apple trees possess in the soils derived from the disintegration of the Gneissic, Potsdam and trap rock.

Paralleling the soils derived from the rock from the mountain and the hills and from the outcropping shaly limestone, occupying approximately the central parts of Washington, Quincy and Guilford townships, and the south-central part of Greene, are soils derived from the disintegration of a limy shale and a shaly limestone. These soils are deep, in which the operation of disintegration are going on at such a rate as to keep them mineralogically fertile, in so far as the rock from which the soil is derived contains the fertility required by plants. These soils will produce large yields of all the regular farm crops, especially wheat, corn and the clovers, especially the red clover and alfalfa. A rotation in which alfalfa, corn and wheat would be the leading crop should yield inviting returns. Potatoes also yield large crops of a splendid, mealy, well-flavored potato. A rotation in which the potato, alfalfa, corn and wheat would occupy the leading positions, should be a money maker in this section. These crops can be gotten to market easily because railroad facilities are good. A considerable acreage of these soils is planted with apples and peaches. The trees of both peaches and apples grow luxuriantly and produce large crops of fairly well colored and flavored fruit, but from experience, up to this time it is evident that the tree growth is not sufficiently vigorous to resist the inroads of diseases nor to throw off the infection and recover from it with as little permanent injury as the peach trees that are grown on the mixture of trap, Potsdam and Gneissic rock; or the apple trees raised on the Potsdam and Gneissic formation. These soils are moderately rolling, easily farmed, and are so well adapted for raising the regular farm crops and the underlying rock is at such a stage of disintegration, that, under normal conditions, there is a constant supply of available fertility, which, with their large water-holding capacity, both so essential in the production of crops, but especially essential in the production of the short season summer cereal and clover crops, that these soils should be used for the production of these crops while the soils not so easily farmed, of which there is a large area throughout this section with superior tree and fruit-growing capacity should be used for raising fruit.

Westward from the above described formation is the rolling shaly limestone, with deep, warm, loamy soils, with large water and fertility-holding capacity, equally as fertile as the limestone soils. West of, and paralleling this shaly limestone and limy shale and limestone formation lies the gently and moderately rolling Trenton limestone valley, with fertile, comparatively easily farmed, and very productive soils. All the land of this valley can be farmed, except

at such places where the undisintegrated limestone remains on the surface, or where it remains so close to the surface as to interfere with deep plowing and where the soil is so thin that plant roots do not have sufficient feeding depth and the soil small water and fertility-holding capacity and consequently crop yields are reduced, or during unfavorable season there are no crops produced on these soils. With these exceptions, the soils are comparatively deep, with sufficient water and fertility-holding capacity to produce, with good farming during normal season, large yields of all the regular farm crops, especially wheat, corn and clovers, including alfalfa.

Climatic conditions in this part of the Cumberland Valley are more favorable than in the same valley in Cumberland county and are nearly as favorable as climatic conditions in the Conewago Valley in southeastern Adams county, which, climatically, is the most favorably located fertile limestone section in the State. With soils equally as fertile as those of this valley in Cumberland county and with climatic conditions such as to make a somewhat longer season, crop yield of such crops as corn should be somewhat larger. It should be possible to raise a more highly developed and larger yielding long season and short season crop in the same year. A crop of wheat followed with a short season crop of cowpeas, either for pasture or to be plowed down, should, with a well-developed agriculture, be possible in this part of the Cumberland Valley; or, it should be possible to raise a crop of winter rye and vetch, cut it for silage and raise a crop of corn for silage on the same land and have a crop of crimson clover sufficiently developed, when the corn is cut for silage to make a splendid cover crop for the soil during the winter. These soils will sustain an agriculture of so intensive a type as this when the organic matter with which these soils were well provided originally has been restored.

The more gravelly of these soils, such as occur where the limestone and the Utica and the Hudson River shale join, are well adapted for raising potatoes and are rich enough to produce a large crop of early potatoes and a comparatively large crop of soja beans, cowpeas or buckwheat the same season—the soja bean or cowpea for pasture and the buckwheat for grain. These are among the best corn soils to be found anywhere in this country and therefore, with careful seed selection and cultivation, as large corn crop can be raised as anywhere in this country, and should be raised.

Franklin county farmers whose farms are located in the limestone valley of this county, should have the ambition to take advantage of climatic possibilities in corn growing and should develop a corn stalk that will produce and ripen within the limits of the season the longest ear with the largest number of rows of grain $\frac{5}{8}$

of an inch long and fully a quarter of an inch in width at the germ end, and an eight of an inch thick. With a corn so highly developed for grain production and one equally highly developed for silage production, yields will be obtained that have not been regarded possible and will furnish an amount of feed, both roughage and grain, that will make possible an increase in the production of milk, butter, beef and pork that will provide the other counties of the State with these products not so favorably located climatically for corn growing but more favorably located for raising other crops such as apples.

This limestone valley occupies nearly all of central and western Southampton township along the Cumberland county line, all of central and western Greene, Quincy, Southhampton and Washington, and all of Antrim but a narrow section along its western border, and western Washington or all of that township not previously discussed, both having the Maryland line for their southern border. This valley increases in width to 15 miles as it approaches the Maryland line, while along the Cumberland county line it is only approximately half this width.

West of and paralleling the limestone valley the soils are derived from the Utica and Hudson River shales and sandstone. The western part of Southampton township has soils derived from this and the limy shales usually accompanying the limestone and directly overlying it. These soils are deep, containing sufficient gravel and loam so that water readily penetrates, and still enough is held by the soil to carry the regular farm crops through an average dry season as well and even better than the limestone clays do, and, therefore, will frequently produce larger yields of such crops as corn and oats during a dry season than the limestone soils will. These soils will produce larger yields of potatoes than any soils throughout this valley. Thorough cultivation will usually cause all acidity, if any should occur, which is seldom the case, to disappear. The land is moderately rolling and is easily farmed. Farming operations can usually begin several days or a week or more earlier than in the limestone clays, a condition which is especially favorable for such cool weather crops as Canada field peas and oats and early truck crops. Advantage should be taken of this condition and a regular money crop such as early potatoes, rye and early wheat or some other early maturing crop for which there is a market, raised and harvested and the soil prepared and a hot weather crop such as cowpeas or soja beans, be raised and plowed down or used for forage, or allowed to ripen and the seed used for a grain ration and the straw for roughage or absorbents, or early maturing winter legumes, such as crimson clover or winter vetch should be sown the previous summer or fall and harvested or plowed down and the land planted with corn

or such legumes as soja bean or cowpea, to be used for grain and roughage and in every case the land seeded with a winter grain or available clover the following fall.

LURGAN TOWNSHIP

Lurgan township lies northwest of Southampton, and with the exception of the Blue Mountain section, its soils are derived from the Hudson River shale and sandstone. Along the Conodoguinet Creek, which forms the eastern and southern boundaries of the township, in the curves of the stream and at such places as Roxbury, some small, nicely rolling sections of loamy soils occur, equally as fertile as the soils derived from the limy shales previously described and with similar adaptations. With these exceptions the slopes to this stream, as well as other streams, are steep and the land is difficult to farm, while in other places the sandy shales and sandstone form small declivities and the land is rocky and stony and fit only for growing forest trees. On the divides between the streams is some moderately rolling land where the standstone does not predominate deep soils, with sufficient water-holding capacity to produce an average corn crop, while where the sandstone prevails the soil, even with a sufficient amount of rain, does not have enough fertility-holding capacity to produce an average corn crop unless the soil contains a large quantity of organic matter and unless, as here indicated, this substance is supplied the average producing capacity of these soils cannot be realized and therefore the supplying of the highest type of organic matter, such as cowpeas, crimson clover and the other clovers which will furnish in connection with the production of money crops this organic matter; must be the aim of the farmers to bring up these soils.

What has been said about farming operations beginning earlier in the more fertile soils along the limestone valley and those derived from the limy shales is even more true of these soils; in fact these soils can be plowed and harrowed and gotten ready for seeding wet without any harm coming from it and, therefore, can be gotten ready for early potatoes or for such early cereals as oats and barley and such clovers as Canada field peas, these harvested and the soil prepared and sown with winter vetch, or what is still better, planted with the late varieties of peas or beans for both forage and grain.

LETTERKENNY TOWNSHIP

This township lies south of Lurgan. The land in the northern part of this township is similar in derivation and configuration to that of Lurgan, just discussed, and can be handled in the same way. Along the eastern border of this township and including the south-

eastern corner of Greene, shales and the limestone intermingle in the formation of the soil and produce soils at such places as Rock Spring, and thence northward, southward, northeastward and eastward of as great and probably greater fertility than those of northwestern Southampton township, and with similar adaptations. In the eastern central part of the township the Utica and Hudson River shale and sandstone formation narrows until it is only about three or three and a half miles wide between the limestone valley to the east of it, previously discussed, and a second limestone valley to the west of it, beginning near Upper Strasburg and extending southwestward into Maryland. This narrowed Utica and Hudson River shale formation is less hilly, the slopes to the streams not as steep and the land above the streams more moderately rolling with deeper soils, more loamy and less sandy than the soils derived from similar formations further north; with larger water and fertility-holding capacity and, therefore, more productive. These are among the best corn, wheat and clover, especially alfalfa, soils in the county or for that matter any other county in the State.

HAMILTON TOWNSHIP

This township lies south of Letterkenny. In this township the Utica and Hudson River shales and sand formation again widens, and throughout the northern part of the township the land above the streams is rolling with some steep slopes down to the streams, and where the softer shales prevail and disintegration has operated more effectively, some nicely rolling sections occur, equal in soil depth and in productive capacity to some of the limestone and limy shale soils along the border between the limestone and the Utica and Hudson River formation. The Conococheaque Creek flows along the dividing line between the limestone and the slate land in this section with similar soil along its course as those already described.

Throughout the southern part of this township and at St. Thomas, lying rather to the southwest, the Utica and Hudson River formation again narrows and both the limestone valleys to the east and west of it widen so that on the Maryland line in Antrim and Montgomery townships, which have this line for their southern boundary, this formation is only about three miles wide. Throughout this narrow Utica and Hudson River shale formation along the border between them and the limestone valleys, there is some nicely rolling land, with deep, easily farmed soils, with large water and fertility-holding capacity, adapted especially for wheat, corn, and clover, but among the clovers, especially alfalfa.

Along the central part of this Utica and Hudson River formation throughout these townships, some steep slopes occur along the streams, but usually the land is moderately rolling with deeper and

more productive soils than where the formation is wider and where it touches the Medina and Oneida sandstone along the Blue Mountain.

The limestone valley, previously referred to as beginning at Upper Strasburg and extending southward through central Letterkenny, Hamilton and eastern St. Thomas and Montgomery townships, has soils derived from the same Trenton limestone formations as those of the valley to the east of the Utica and Hudson River shales and sandstone. These soils are equally as fertile with less extensive outcroppings of the underlying limestone as the soils in the valley to the east and are adapted to the same intensive kind of farming that can be practiced there. On the west, as on the east side of this valley, a narrow strip of Utica and Hudson River, limy shale and sandstone combines with the limestone in the formation of the soils, producing soils similar to those occurring in southern Letterkenny township and discussed under that township. This is especially true of a narrow strip of these soils extending from the base of Casey's Knob in southern Montgomery township to the base of Parnell Knob in St. Thomas township. The soils in the vicinity of the town of Mercersburg are derived from this combined formation and, as all know who have visited the place are fertile.

West of the Utica and the Hudson River shale formation, above discussed, the limestone again comes to the surface and forms a valley beginning with Bears Valley, between Casey and Two Knob mountain and extending northward to Bear Valley between Parnell and Jordan Knob, with similar soils and similar capacity and adaptations to those previously discussed. West of this limestone valley is still another narrow Utica and Hudson River shale ridge and west of this ridge, paralleling Cove Mountain, still another limestone valley extending from Cross Mountain and Punch Bowl and the Corners, in Montgomery township, through Peters township northeastward to Fort Loudon and thence northward to Path Valley, to be referred to later, with soils of similar derivation and with similar capacities and adaptations of these soils. Along the lower slopes of Casey's Knob, Two Knob and Cross Mountain in southern Montgomery township are some deep soils derived from the debris brought down from the mountain and from the underlying shales, with splendid productive capacities, adapted to the raising of all agricultural crops, but especially adapted for potatoes, wheat, corn and clovers. A rotation of potatoes, wheat and clover it seems should be an inviting agricultural proposition.

Along the lower slopes of Parnell and Jordan's Knobs, in St. Thomas township, the northeastern extremity of the above described limestone valleys and shale and sandstone derived soils of similar origin with similar capacities and adaptations occur.

WARREN TOWNSHIP

This township occupies the southwestern corner of Franklin county, with the crest of Tuscarora Mountain forming the boundary between it and Fulton county, and the crest of Cove Mountain forming the boundary between it and Montgomery township. The soils of the township are derived from the Oneida and Medina sandstone, which form the previously named mountains, the Clinton shale, the Lower Helderberg limestone, the Oriskany sandstone, and the Marcellus shales which occurs in the center of Little Cove, through which flows Little Cove Creek. The only soils of agricultural importance in this Cove are those derived from the Lower Clinton shale, the Lower Helderberg limestone and the Marcellus shales. These together form a section of land in this Cove of splendid fertility, with deep soils, with large water-holding capacity, adapted to the raising of all the agricultural crops referred to in the discussion of the soils derived from the limestone and the limy shales of the limestone valleys, except that this land is more difficult to farm because it is more hilly and stony than the limestone soils of the greater valleys.

The soils of western Peters township, west of the valleys previously described, are derived from the Medina and the Oneida sandstone and are mostly rough, rocky and stony, with a steeply hilly and mountainous topography adapted for forest growing with here and there a less hilly section adapted to farming.

Western Hamilton, Letterkenny and Lurgan townships have soils derived largely from the more sandy shales and sandstone strata of the Hudson River shales formation in the valleys and along the lower slopes of the mountains while the soils of the higher parts and the crest of the mountain are derived from the Medina and Oneida sandstone, except Horse Valley in the extreme western part of these townships, which has soils derived from the Clinton red shale. About all of this land is rough, rocky, stony and steeply hilly and mountainous, and little of it adapted to farming except here and there a rolling stretch among the hills and mountains or in the wider valleys, such as Horse Valley, that will produce agricultural crops or fruit, but these places are usually so inaccessible that whatever may be raised is difficult to get to market except it be livestock. Some of the rolling sections referred to will produce good pasture, and wherever possible, should be used for this purpose; but a better thing to do would be to keep all this land in forest, for which it is better adapted than anything else.

METAL TOWNSHIP

Metal township lies west of Peters and Letterkenny, on the Huntingdon county line. The soils of the township are derived from the Trenton limestone, the Utica and Hudson River shales and slates, combined with some sandstone from the Medina and Oneida Mountains which encompass Path Valley, in which the farming land of the township is located.

The land in the limestone valley is rolling, with deep loamy soils mixed with gravel and some sandstone, having large water and fertility-holding capacity, adapted to raising all the regular farm crops; but especially adapted for raising wheat, corn, clovers, among them alfalfa. Splendid yields of a hard, red, high-milling quality wheat can be raised throughout this limestone and partly Utica and Hudson River shale valley. It seems that this should be one of the sections of the State for raising seed wheat to keep up the grade and the yield.

The west branch of the Conococheaque Creek flows in the Utica and Hudson River shale and slate formation in part of this valley, and along its course are some rolling sections with fairly fertile soil well nigh equally as fertile as the limestone, especially adapted to raising potatoes, the clovers and wheat.

FANNETT TOWNSHIP

This township occupies the northwestern corner of the county. The soils of the township are derived from the Trenton limestone, the Utica and Hudson River shales and slates and the Medina and Oneida sandstone, practically the same as the soils of Metal township, except that the Utica and the Hudson River formation is the basis of a larger area of soils than in Metal township, covering all of Amberson's and Burn's valleys, the former along the eastern border of the township in the northern part of which the Concocheaque Creek has its origin, and the latter in the northwestern corner of the township in which the Tuscarora Creek arises. The limestone soils are similar in depth, water and fertility-holding capacity and agricultural adaptations.

What has been stated in regard to climatic conditions and adaptations of the limestone valley of the eastern central part of the county for raising corn and long season crops, is equally true of all except the highest of the mountain elevations throughout the sections outside of this valley. The northern and northern-central parts of the county are drained by the Conodoguinet Creek and its tributaries flowing northeastward into the Susquehanna River. The northwestern corner is drained by Tuscarora Creek flowing north into Juniata county, and finally into the Juniata River. The remainder

of the county is drained by the Conococheaque Creek, flowing into the Potomac River, except the southeastern corner, which is drained by the Little Antietam Creek, which also flows into the Potomac. The railroad facilities of the county are fairly good, except in the western part, where they could be better.

CUMBERLAND COUNTY

Cumberland county was the sixth county in Pennsylvania to be erected in 1750, one year after York county, and was named after a county in England. The agricultural resources are equal to any other county of the State. None can boast of more highly cultivated and productive farms.

It contains 337,920 acres, of which 263,246 acres is land in farms, and of which 228,554 acres is improved farm land; 44,426 acres were planted in corn in 1909, yielding 879,323 bushels; 24,921 acres were sown with oats, yielding 618,518 bushels; 54,584 acres were sown with wheat, yielding 1,015,937 bushels; 27 acres were sown with buckwheat, yielding 215 bushels; 3,038 acres were sown with rye, yielding 37,513 bushels; 3,421 acres were planted with potatoes, yielding 203,987 bushels; 48,742 acres were sown with all forage crops, yielding 53,110 tons of the various kinds of hay.

At this time Cumberland county had a population of 54,479 to feed, 20,924 cattle, 10,531 horses, 1,879 mules, 34,731 swine and 16,343 sheep.

The county lies north of York and Adams counties, east of Franklin, south of Perry and west of Dauphin. The underlying rock strata from which the soils of this county are derived begin with the Gneissic and Potsdam sandstone, which form the mountainous soils of the southern part of the county, the lower limestone shales, the Trenton limestone, from which the soils of the Cumberland Valley are derived, the Utica and Hudson River shales, of which the soils north and west of the limestone valley are derived, and the Oneida conglomerate along the mountain and a few narrow trap dykes.

Southern Monroe, southern South Middleton, southern Dickinson, southern Penn, southern Newton and southern Southampton have soils derived from the Gneissic and Potsdam sandstone rock.

MONROE TOWNSHIP

Monroe township occupies the southeastern extremity of the county with the York county line for its southeastern and southern boundary. As previously stated, the southern part of this township has soils

derived from the Potsdam sandstone and the conglomerate, together with the Gneissic and trap admixture. The land is rough and hilly, difficult to farm, with soil of considerable depth, splendidly adapted to growing forest trees such as the rock oak, the black oak, the chestnut and the hickory, and along the creek bottoms, the beech, the birch and the maple. Where the hillsides are not too steep and the land too rocky and stony so that some cultivating can be done, these soils will produce large fruit crops, such as apples and peaches, and larger returns can be realized than from the regular farm crops in the richer valleys of the county.

SOUTH MIDDLETON TOWNSHIP

This township lies west of Monroe on the Adams county line. Along the Adams county line and for some distance north of it the soils are largely derived from the Gneissic and Potsdam rocks, with the former predominating, and containing some trap. Some of this land is hilly and some steeply hilly, but a considerable area is moderately rolling with deep soils, with large water holding capacity adapted to raising the regular farm crops, but better adapted to raising fruit, especially peaches and apples. Apple trees grow thriftly here and produce a highly colored, nicely flavored fruit, but it seems that with the area of these best peach soils of southeastern Penna. somewhat limited, that in so far as conditions justify, the larger acreage should be devoted to raising peaches, with such agricultural crops and methods of cultivation as experience may demonstrate, will lengthen the life of the tree and maintain its producing capacity of a highly colored and nicely flavored fruit. North of this section, along the northern slope of the mountains in this township, the Potsdam sandstone predominates and the soils derived from its disintegration are stony, gravelly and sandy loams with some small sections of clay soils along the streams. The stony, gravelly and loamy types of these soils, which are usually deep when located on the moderate slopes and the more rolling uplands, are adapted to raising the agricultural crops, especially wheat, which, wherever the land is well farmed and some lime and phosphoric acid and manure are applied, yields inviting returns of a hard red wheat with good milling qualities.

But these soils have demonstrated that the apple is the crop, for the production of which they have special adaptations because they have, for a number of years produced, where careful pruning has been practised, a highly colored, nicely flavored fruit without the application of any artificial fertilizer.

It seems that with such conditions, these soils should be largely devoted to raising fruit with such varieties of apples, in connection with such agricultural crops and methods of cultivation as experience may demonstrate, will develope the strongest disease resisting trees, with large producing capacity of a highly colored, well developed, nicely flavored fruit.

DICKINSON TOWNSHIP

Dickinson township lies west of Middleton, with the York and Adams county lines for its southern boundary. This township has only a small area of soils derived from the Gneissic, trap and Potsdam rocks, with similar adaptations to similar soils of Middleton township, previously discussed; and similiar to those discussed in the vicinity of Idaville, Adams county. North of the Gneissic rock the Potsdam sandstone and conglomerate formation prevails with soils such as occur in Middleton township, except along Mountain Creek where some low land of this formation, needing underdrainage occurs and also an area between Mountain Creek and Toga Run with less stony, more moderately rolling, deeper and more easily farmed soils than the more hilly and steeper formations and better adapted for raising the agricultural crops and the lower and more clayey types not so well adapted for raising fruits, probably on account of the poorer air drainage and the more clayey soils.

Extending through the south central part of this township to Pinegrove Furnace in Penn township along Mountain Creek, the Silurio Cambrian limestone remains in a narrow strip and enters the formation of the soil, producing a deep fertile, though mostly a rough and stony soil with large water holding capacity adapted to raising all the regular farm crops, especially wheat, and among the root crops, potatoes. Apple trees growing along the hillsides in this formation look thrifty and bear well and probably produce even larger crops than the trees in the Potsdam soils.

From this area northward to the Limestone Valley, the Potsdam rock again prevails and is the predominant factor in the mineral structure of the soil.

PENN TOWNSHIP

Penn township lies west of Dickinson with the Adams county line for its sounthern boundary. The soils of the southern part of this township are derived from the Gneissic and the Potsdam quartzite and conglomerate, and in many places the land is stony. But considerable areas are moderately rolling and can be readily farmed and will produce splendid crops of rye and buckwheat when carefully farmed, but like the soils of the previously discussed township, they are better adapted for raising apples and peaches than any other

crops. Pinegrove Furnace is located in this township where, as already indicated, the limestone outcrops and takes part in the formation of the soil northward to the Limestone Valley. The soils are similiar to those previously discussed, except on the divided between the Mountain Creek and the Yellow Breeches Creek is a rolling upland of considerable extent with sandy soils apparently adapted to the raising of such crops as buckwheat but better adapted to raising forest trees and perhaps apples. Southeast of the upland the land is stony and rough.

NEWTON TOWNSHIP

Newton township lies west of Penn and comes to a point on the Adams county line. The soils of the southern part of the township are similar in derivation and adaptation to those of Penn township having the rolling upland and the rough and stone formation.

SOUTHAMPTON TOWNSHIP

Southampton township lies west of Newton township and occupies the southwestern part of the county. The soils in the southern part of this township are derived largely from the Potsdam sandstone, quartzite and conglomerate. The "Big Flat," referred to in Adams county, extends into this township, the soils of which are derived from the disintegrated Potsdam sandstone and quartzite. The soil on the gently rolling flat is largely a sandy loam, except in such places from which the sand and loam has been washed away and the underlying stony formation remain, here the land is stony. After the soil is broken, which is by no means an easy undertaking, and thoroughly cultivated it produces comparatively large crops of buckwheat, rye and potatoes, and if a crop rotation of clover, potatoes and rye would be established and everything fed on the farm except potatoes and returned to the soil, fair returns could be obtained.

Apples and peaches are being raised here with fair success. The peaches are not as highly colored and nicely flavored as the peaches raised in the soils derived from the Gneissic, Granitic and Potsdam rock. The apples are highly colored and have a good flavor, but the tree growth, when compared with the tree growth of the soils derived from the Gneissic and Potsdam, is stunted, and unless this growth can be developed by fertilization the likelihood is that the trees will be short-lived, because if soil or climatic conditions are such that larger growth is prevented, soil enrichment will be necessary or premature death of the trees will follow. These soils should be devoted to forest growth and should be maintained in forest permanently so that both the soil would constantly be enriched and the owner have returns that would be easily gotten off the land and

marketed at a profit. A considerable area of this flat lies in Adams and Franklin counties with soils of similiar derivation and adaptation.

Northward from the "Big Flat" the land is hilly, rough and stony; little of it adapted to farming but a large acreage of it would produce apples. A considerable area is being used for raising this fruit. Peaches are also raised but the fruit does not have the quality and flavor of that produced on the Granitic, Gneissic and Potsdam soils.

North of the hilly and rock Potsdam sandstone and along the lower slopes and the base of the hills and parelleling the Potsdam, the soils are derived from the disintegration of the Lower Trenton magnesia limestone underlying them as well as from some of the rock brought down from the hillsides and, therefore, the land in many places among the hills and in some lower places where disintegration of the rock coming from the hillsides has not proceeded beyond the stony soil formation, the land is stony with numerous outcroppings of the underlying limestone, and ovally shaped small vales beneath which the limestone has been disintegrated and carried away by the water and sink holes formed, making an ocean wave like surface with soils derived from limestone and sandstone of splendid fertility.

But wherever the soils are derived from the underlying slaty limestone, they are loamy, and on the sides of the sink hole undulations sometimes stony, while the more rolling sections contain considerable areas of clay soils. This land is generally moderately rolling, with soils that are deep, with large water holding capacity, when treated right agriculturally, easily farmed and will produce well all the regular farm crops. But wherever the underlying limy rock in connection with the Postdam from the hills enters the formation of the soils, these are specially adapted for raising a hard red wheat with superior milling qualities.

These soils, the more gravelly and loamy types, will also produce large yields of potatoes and the clovers, red, alsike, the Mammoth and alfalfa. With these natural adaptations, a rotation of crops, composed of clovers and wheat and potatoes in which the wheat and potatoes would be the money crop could be adopted that could be made to yield inviting returns. With an operation like this the clover hay should be fed and the necessary grain ration purchased and the manure applied on the clover sod. The more loamy and clayey types of these soils, because of the underlying limestone from which they are largely derived, are equally as well adapted for raising a hard red wheat, and wherever the organic component of the soil is supplied and maintained by plowing down sods and applying manure will produce large yields of clover, red, alsike and alfalfa. From what has been stated it seems that this is a section well adapted

for raising red clover seed from the second crop of clover after cutting a crop of clover hay. Soils that have a special adaptations for raising clover seed should be used in so far as possible for raising this seed.

MONROE TOWNSHIP

Monroe township, already referred to in the previously discussed soils, contains a large acreage of soils derived from the underlying limy slate and transported sandstone rock as well as several small areas of soils in the eastern and southeastern part of the township, derived from the intrusive trap in connection with the limestone, making, in many places, a rough but fertile soil, the capacities of which it seems are limited only by climatic conditions.

SOUTH MIDDLETON TOWNSHIP

South Middleton township, also referred to in the previous discussion, contains a considerable area of these soils. Near the trolley line west of Mt. Holly Springs is an area of what appears to be intrusive rock, with soils derived from these rock and the local limestone and sandstone differing in the last component from the soils in Monroe township. At Boiling Springs the trap dyke, which crosses Cumberland county about 4 miles east of Carlisle in a slightly northeastern and southwestern course, brings up the trap rock and it together with the limestone form the basis of the soils in a limited area at this place with adaptations such as have been referred to before.

DICKINSON TOWNSHIP

This township, previously discussed, also contains a considerable area of the slaty limestone formation along the foot of the mountain as well as the area of hilly and rocky land along the mountain both of similiar capacities and adaptations as the soils of the previously discussed townships.

PENN, NEWTON AND SOUTHAMPTON TOWNSHIPS

Penn, Newton and Southampton townships have a similiar belt of soils along the foot of the mountain, but of greater width, with more rolling land, more easily farmed but not more productive. Apple and peach raising has become quite an industry along the foot of the mountain. The soils derived from the Potsdam sand and the limestone, together with the iron ore outcrops which occur throughout this formation are, in addition to the adaptations for raising specials, of the regular farm crops previously discussed adapted to raising apples and peaches especially apples. A considerable acreage of this land has been planted with this fruit in Cumberland county, and

such returns have been obtained that land values have more than doubled along the hilly slopes and the foot of the mountain as well as for some distance westward where the more stony and rolling soils occur.

The derivation of these soils make this section a part of that natural fruit belt of southeastern Penna., beginning south of this State and extending northeastward along the west side of South Mountain through Franklin and this county, parts of Berks, Lehigh and Northampton counties, differing, however, in that the soils of these two counties are derived well nigh entirely from the Potsdam sandstone and the slaty lime and magnesia limestone strata, while throughout the counties further northeastward other rocks enter the formation of the soils the effects of which manifest themselves both in the vigor and the growth of the trees as well as in the size color and flavor of the fruit. The apple raising industry is not old and extensive enough throughout this formation to determine what the natural or artificially stimulated length of the profitable bearing period of apple trees of highly developed and well colored and flavored fruit will be or can be made to be.

THE LIMESTONE VALLEY OF CUMBERLAND COUNTY

The soils derived from the disintegration of the Trenton limestone are the most extensive and important group of soils of this county, embracing more than one-third of its whole area and extending from the Susquehanna River southwestward through the entire length of the county into Franklin county to the southwest.

LOWER ALLEN TOWNSHIP

The soils of lower Allen township, bordering on the Susquehanna River, are derived, with the exception of a narrow strip in the vicinity of New Cumberland, from the limestone strata. This narrow strip of soils, derived from the Utica and Hudson River shales and the underlying limestone strata, extends southwestward into Upper Allen township, and east of Shiremanstown widens and covers a considerable area of the township with loamy, and where the Utica and Hudson River shales prevail, shaly soils, while where the limestone and the more easily disintegrated shales predominate, clayey soils. The more shaly and loamy of these soils produce a splendid high milling quality, hard red wheat. They are also adapted, especially the shaly types, to peach and apple raising as well as for raising potatoes and for raising early truck crops for a market such as is afforded at Harrisburg. Much of this land should be used for this purpose. The soils of the remainder of both the Allen townships are derived from the limestone strata, except the southeastern corner of Upper Allen,

which are derived from the Mesozoic shales and sandstones, the only section of this formation in this county fully discussed in Adams county.

The limestone land of this valley is largely gently rolling with an occasional section where it might be termed moderately rolling. Practically all of this land can be farmed except in such places where the limestone remain on the surface, of which there are considerable areas on well nigh every farm of any size. Usually in close proximity to these surface outcrops of the limestone are sections of larger or smaller extent, where the limestone does not outcrop and where the underlying limestone comes so close to the surface as to interfere with deep plowing, and where, therefore, the soil is so thin that during only a limited drought, the soil will become so dry as to materially reduce crop yields.

With the exception of the sections referred to, the soils of this valley are moderately deep, with sufficient water holding capacity, except where sink holes occur, to successfully carry the regular farm crops through the average drought prevailing in this section. The soils are fertile, easily farmed and will successfully produce all farm crops adapted to the climatic conditions prevailing here. This valley is also adapted to the highest developed intensive farming that it is possible to practice in this part of the State. Every two acres of improved farming land of this valley will produce a sufficient amount of roughage and grain to feed one dairy cow for one year, if rotation of crops are arranged so that a clover will follow a cereal. With similiar practice even a smaller acreage will produce all the roughage and grain needed to finish a two or three year old steer for the most exacting beef markets; or enough of such crops as are needed for making baby beef or making yearling steers weigh from 1,000-1,200 pounds can be raised on the same area. The natural rich soils of this valley can be made to produce a roughage and a grain crop in one year and with the right use of the manure, the soil can be improved by this operation.

In any one or all of these operations corn should be the main cereal grain. The corn growing season throughout this valley ranges from 120-130 days and the development of a corn stalk that will take approximately this entire season in producing and ripening the longest ear with the largest number of rows of grains, at least five-eighths of an inch in length, should be the effort of every corn grower. Ears twelve inches long with 18-22 rows of grain $\frac{5}{8}$ of an inch long can be ripened in this valley. Those acquainted with this type of corn will know how much such an ear will shell and therefore how much can be produced on an acre. Other methods of increasing the production of the acre and at the same time maintaining and even increasing the fertility of the soil might be suggested.

The following townships and parts of townships, beside Lower Allen and Upper Allen, lie within the valley. Southern East Pennsboro and southern Hampden, southern Silver Spring and northern Monroe, southern Middlesex and northern South Middleton, northern Dickinson and Penn and all of West Pennsboro, nearly the whole of Newton and all of central and northern Southampton. About 4 miles east of Carlisle a trap dyke of some dimensions and elevated from 40-50 feet above the surrounding county, passes in a slightly northeastern and southwestern course through eastern Middlesex and western Monroe townships, with stony, loamy and clayey soils derived from the disintegration of the locally so called "Iron Stone" and other metamorphosed rock. The stony and even the rocky types of these soils are adapted to apple and peach raising, while the clayey, when carefully farmed, produce fairly large yields of hard red wheat and timothy hay.

Carlisle, the county-seat of this county, is located along the dividing line between North and South Middleton townships, in one of the richest agricultural districts of the county or of the State with farms as well farmed as any in the State and likely as productive, but not as productive as it is possible to make these farms. Alfalfa, making yields of four and five tons of hay per acre during a season, has been, and is now being raised in this section.

WEST PENNSBORO TOWNSHIP

West Pennsboro township, lying west of North Middleton township, is the only township of the county nearly entirely located in the Limestone Valley. At Newville, in the northwestern part of the township, the Utica and the Hudson River shales project into the limestone valley, and make a hilly section with soils derived from these strata not as fertile as the limestone. Several smaller remanents of these strata southwestward of Newville, together with the limestone underlying them and with the limy shales evidently occuring here, enter the formation of the soils producing soils similiar to those at Shiremanstown, in Lower Allen township, and with similar adaptations and capacities. This formation extends into Newton township. This limestone valley contains approximately 70,000 acres of this fertile limestone soil, and if this land would be developed so that the soil would produce up to its capacity, there would be a demonstration of what the many thousand of acres of limestone soils derived from the same limestone formation throughout this and many parts of the State are capable of doing.

North and west of the limestone valley, the soils are derived from the Utica and the Hudson River slates and shales lying immediately above the Trenton limestone, and making an escarpment which gradu-

ally rises from fifty to a hundred feet above the limestone formation. The rock is made up of thin strata of compressed shales which, in many places, have acquired a slaty structure and, therefore, form the slaty soils. This slaty structure, under the agencies of disintegration, forms slender fragments of various sizes which, when mixed with the more disintegrated materials, forms what are locally known as slaty soils or slaty loams. Where disintegration has proceeded further, or where the underlying strata are composed of more readily disintegrated material, the slaty fragments do not occur or are not as large and the soil is deeper, more fertile with larger water and fertility holding capacity, and adapted to a larger variety of crops. Where the limy slates occur the land is equally as fertile as in the Limestone Valley and equally as productive.

The outcrop of the Utica and the Hudson River slates and shales from which these soils are derived, ranges from four to six miles in width and extends through the entire length of the county. The land is moderately and steeply rolling. Usually the descent to the streams are steep, while the uplands are moderately rolling, with well rounded hills, ranging in height of fifty and more feet above the surface of the streams. The soils on the steeper hillsides, unless derived from the more easily disintegrated strata, wash readily and therefore the soils are thin, frequently stony and the crops quickly affected by even slight droughts, while where the land is rolling and disintegration has penetrated deeper and little washing away of the soils has occurred the soils are comparatively deep and produce, when conditions are just right, large crops; but even where the soils are deep, the water, because of the broken up condition of the underlying strata, seeps through into the rock beyond the reach of the roots of agricultural plants and crop yields are curtailed during only a normal drought. These soils are easily farmed. They can be plowed and cultivated wet or dry without any injurious results except where the small areas of clay soil derived from this formation occur.

This peculiar soil condition should be taken advantage of by the farmer and such early summer maturing winter crops as crimson clover, rye and winter vetch should be sown in the fall; and such medium early summer maturing crops as oats, Canada field peas and early potatoes sown and planted early in the spring should be raised.

After the rye and vetch is harvested the land could be sown with a dry weather clover should as the cowpea which could be pastured by hogs and some time in early September plowed down, or preferably, unless the growth is too heavy, cut up with a disk harrow and the land sown with wheat, or again with rye and Russian vetch, which would be plowed down early the following spring and the land planted with early potatoes or sown with Canada field peas and oats. By

means of an operation of this kind a sufficient amount of organic matter could be introduced into the larger area of even the more hilly of the shaly loam soils to largely prevent washing and to hold sufficient quantity of water to carry a corn crop through an ordinarily dry summer.

In northern East Pennsboro and Silver Spring and eastern Middlesex townships, several areas of deep, easily farmed fertile soils, derived from the limy shales of this formation occur. These soils are well adapted for raising the cereal grains, potatoes, the clovers, such as red, alsike, alfalfa, the cowpea, the soja bean and the winter vetch. With an array of crops such as these, little difficulty should be experienced in arranging a rotation to yield splendid returns for the farmer, as well as crops to maintain and even increase the productive capacity of the land.

The trap dyke, referred to in the discussion of the limestone valley, crosses this shale and slate formation along the line between Silver Spring and Middlesex townships and the rock combines with the Utica and Hudson River strata in the formation of the soil. Besides the formations above referred to, the Hudson River shale and slate is made up of red, yellowish and grey strata giving rise by weathering to red and grey colored soils among which the red are usually the more fertile.

The following townships and parts of townships have soils derived from these shales and slates: Central and northern East Pennsboro, Hampden, northern Silver Lake and northern Middlesex, central and northern North Middleton, all of Franklin, Milford, and nearly all of Hopewell. These soils need but small, if any, applications of lime and in many instances where the limy shale strata occur, no lime need be applied except in the valleys where disintegration has proceeded far enough to form clay soils. The shaly soils derived from these strata are especially not benefited by liming. An application of phosphoric acid, together with a practice such as was outlined in the beginning of the discussion of this formation, will usually yield splendid returns. If the straw and the manure are returned as they should be to these soils it should not be necessary to apply much potash. Some fruit—apples and peaches—are being raised on these soils but trees do not make the strong, natural, luxuriant, vigorous disease resisting growth that the same trees would make on the combinations of soils in the eastern and southern parts of the county.

Along the lower slopes of the Blue Mountains, the crest of which forms the boundary line between this and Perry county, are considerable areas of land where disintegration of the Utica and Hudson River shales and the Medina and Oneida sandstone that came down from the mountain has proceeded far enough to form a loamy soil containing a considerable admixture of these sandstones. The land

is more fertile than the shaly soils derived from the Hudson River strata and has larger water and fertility holding capacity and will invariably yield more inviting returns. Further up the slopes are some moderately rolling though limited areas, the soils of which are derived from the more easily disintegrated Medina and Oneida sandstone with considerable water and fertility holding capacity, easily farmed and adapted for raising such crops as buckwheat, wheat, and with the application of carbonate of lime, the clovers. It seems the cowpea should thrive in these soils. Apple trees look thrifty and make a fairly vigorous growth and produce, with careful handling, fair crops of nicely colored fruit, but do not seem to have the disease resisting capacities that the same varieties have in the South Mountain soils or the Catskill shales. Peach trees seem to thrive better than apples and produce larger yields of a nicely colored, well flavored fruit than do apple trees, and therefore it seems a larger area of the land adapted for raising this fruit, should be devoted to it. Nearly all of this east sloping mountain side is adapted for growing forest trees and should always be, as it now largely is, devoted to this crop. The county is drained by the Yellow Breeches and the Conedoquinet Creeks and their tributaries, flowing eastward into the Susquehanna River.

DAUPHIN COUNTY

The county of Dauphin was erected March 4, 1785, It contains 333,440 acres, of which 214,390 acres is land in farms, and of which 170,512 acres is improved farm land. 27,820 acres were planted in corn in the year 1909, yielding 570,938 bushels; 22,507 acres were sown with oats, yielding 531,923 bushels; 27,285 acres with wheat, yielding 463,581 bushels; 207 acres with buckwheat, yielding, 2,329 bushels; 3,300 acres with rye, yielding 43,065 bushels; 3,160 acres were planted with potatoes, yielding 188,472 bushels; 104 acres planted with tobacco, yielding 109,936 pounds; 45,799 acres were sown with all forage crops yielding, 48,708 tons of various kinds of hay. Of the 170,512 acres of improved farm land, 130,182 are used for raising farm crops, while 40,330 were not so used and were likely producing weeds. At this time Dauphin county had a population of 136,152 to feed, 20,889 cattle, 6,123 horses, 1,974 mules, 16,541 swine and 1,431 sheep.

This county lies south of Northumberland, west of Schuylkill and Lebanon and north of Lancaster on the east bank of the Susquehanna River. The geological strata, from which the soils of the county are derived, begin with the Trenton limestone and extend through the Utica and Hudson River shales, the Oneida and Medina sandstone,

the Clinton red shale, the Hamilton shale, the portage flags, the Chemung shales, the Catskill red shale and sandstone, the Pocono sandstone, the Mauch Chunk red shale, the Pottsville conglomerate, into the coal measures, and in the southern part of the county the new red shale of Mesozoic Age, together with the intrusive trap dykes, all enter into the formation of the soils. Londonderry, Conewago, southern Lower Swatara have soils derived from the intrusive trap dykes and the new red shale and sandstone.

LONDONDERRY TOWNSHIP

Londonderry township occupies the southwestern corner of the county and has the Susquehanna River for its western and the Conewago Creek, which forms the boundary between Lebanon and Lancaster counties, for its southern boundary. The soils of the township, as already intimated, are derived from the trap and red shale. In the southwestern part of the township for a considerable distance along the river and east of the river, quite an area of so called river "bottom land" occurs with deep, sometimes fine sandy, then again gravelly and loamy soils with large water and fertility holding capacity, adapted to the highest type of intensive farming along the dairy and the livestock industry as well as for regular corn and clover farming, but more especially are these soils adapted for raising early truck crops. The soils are warm, can be plowed and cultivated early and are naturally fertile and can be maintained in such a state of fertility by the use of farm measures for the utilization of which they have special capacity that these crops will grow quickly and be of superior quality.

Because of the ready response of these soils to the application of the manures and their retentive capacity of both water and fertility, it is possible to produce a number of these crops adapted to follow each other on the same land in the same season and large returns can be realized from a small acreage. The islands in the Susquehanna River, belonging to this county, have soils of similiar derivation as the river lands along the banks with similiar capacities and adaptations.

East of the river bottom, the soil is derived from the red shale and sandstone, previously referred to. These soils are fairly deep, except on the steeper slopes of the hills where they are sandy and gravelly, with limited water and fertility holding capacity, adapted to raising early summer crops such as wheat, timothy and red clover, while the more gently rolling, the deeper, more loamy soils with larger water and fertility holding capacity are adapted to raising all the regular crops, but are specially adapted for raising large crops of wheat and corn and the clovers. The land is moderately and some

gently rolling, easily farmed and normally does not wash readily. Tobacco also yields fairly large crops of a good quality. East of this red shale section, coming in from Lancaster county, the trap rock and the changed red shale make the basis of a strip of soils extending from the Conewago Creek to, approximately, the central part of the township where another section comes in from the river and the combined sections extend to the northeastern corner of the township. The land is usually stony, though some limited sections are comparatively free from stone and are easily farmed. The soil, whether stony or not, is deep, with large water and splendid fertility holding capacity, adapted to raising the regular farm crops. But it seems especially adapted for raising wheat of which with good tillage these soils will produce a hard red high milling quality.

These soils will also produce large yields of a good quality of corn and oats, and among the clovers, the red, the alsike and alfalfa. The rough, hilly and stony types of these soils should be planted with apples and peaches, especially peaches, because they will produce without any artificial fertilizating vigorous disease resisting trees which bear large crops of well developed, highly colored, nicely flavored fruit. These, like those of similiar sections along this same formation, are natural peach and apple soils. In the southeastern corner of the township the soils are derived from the same rock as in the south central section with similiar capacities and adaptations.

As previously indicated, the soils in the northeastern section of the township are derived from the trap and the changed Mesozoic rock combined and are similiar in capacity and adaptation to those previously discussed. A section of hilly land extends in a narrow strip from the northern border of the township toward the central part with soils derived from the Mesozoic hard red sandstone with limited water and fertility holding capacity, adapted to raising early summer ripening crops such as wheat, which ripens before the hot and dry weather of the summer damages the crops. This land can be cultivated early. Advantage should be taken of this condition and an early spring ripening winter crop such as rye, wheat or crimson clover should be raised and the land sown or planted with a dry weather cereal, such as Kaffir corn, cowpeas or sweet clover—the latter two are soil improving crops.

The limestone touches the northwestern corner of the township, but the soils of this part of the township are little effected by the limestone. The soils in this part of the township partake of the sandy nature of those previously discussed, but are not as stony and hilly, with large water and fertility holding capacity, but not sufficiently large to produce large crops of corn when the season is dry or only even slightly dry; therefore these soils should be cropped in

such a way that fairly good yields of spring wet weather crops could be raised in the earlier part of the season and summer dry weather crops in the later part of the season, and in this way both objects of farming that of producing human nutrition and maintaining and improving the fertility of the soil be accomplished.

CONEWAGO TOWNSHIP

This township occupies the southeastern corner of the county, with the Conewago Creek or the Lancaster county line for its eastern boundary. The soils of the township are derived from the Mesozoic shale, sandy rock and sandstone and the mixture of trap and the changed Mesozoic. In the southwestern corner and in the western part of the township, the soils are the same as they are in the southeastern corner of Londonderry, with similiar capacities and adaptations. In the central part of the township, a trap dyke comes to the surface and spreads northeastward to and beyond the northeast line of the township, and also to the southern border and connects therewith a similiar dyke which parellels the Conewago Creek with soils derived from the same rock as those referred to in Londonderry, except that these soils are not as extensive and not generally as rough with superior adaptations for the raising of the regular argicultural crops.

In the eastern and the southeastern parts of the township, except the northeastern corner, previously referred to, the soils are derived from the red shale and sandstone of the Mesozoic Age and are adapted for raising the same crops as the soils of southeastern Londonderry. In the northwestern corner of the township the sandstone formation prevails with soils that are more stony than the surrounding formations, with small water and fertility holding capacity adapted, as previously stated, for raising winter and early spring moist weather crops followed with summer dry weather crops. These soils when derived from Granitic and Mesozoic rock are well adapted for raising apples and peaches, but will not produce as large sized, highly colored, nicely flavored peaches as the combination of Granitic, and Mesozoic rock will.

DERRY TOWNSHIP

This township lies north of Conewago with the Lebanon county line for its eastern and the Swatara Creek for its western boundary. The soils of the township are derived from the Trenton limestone, the Mesozoic shale and sandstone with a small section of Utica and Hudson River shales in the northern part, which will be discussed later.

In the south central part of the township, which touches the northwestern corner of Conewago township, the soils are derived from the Mesozoic sandstone making, as in Conewago, hilly and in many places stony land adapted for raising the same kind of crops previously discussed. Along the line of contact between the Mesozoic and the limestone formation the land is usually rolling with deep equally as fertile soils with as large and even larger water and fertility holding capacity as the limestone soils. These soils are less clayey, more easily farmed and adapted to a larger variety of crops than the limestone soils are but unfortunately the acreage of these fertile soils derived from the two underlying strata is limited, usually confined to a narrow strip along the slope rising from the Limestone Valley or a wider plain at the foot of this slope. These soils are among the best wheat and corn soils in this State. They will produce large yields of a high milling quality hard red wheat. Clovers—the red, alsike and alfalfa thrive in these soils.

North of the region of soils derived from the combined Mesozoic and limestone strata, the true limestone soils occur in this township, extending from beyond the eastern boundary line to and beyond the Swatara Creek. The land throughout this valley is moderately rolling with deep easily cultivated soils with large water and fertility holding capacity adapted to raising all agricultural crops that will thrive under prevailing climatic conditions. This limestone section together with a large area of the soils derived from the shaly strata of the Mesozoic rock comes within the limits of the soils in southeastern Penna. adapted to raising large crops of corn for grain, and among the legumes, the red and alsike clovers and alfalfa, the soja bean and the cowpea; and for an early spring sowing crop the Canada field pea and oats to furnish a highly nutritious roughage and grain to balance up the corn ration when fed to cows or to cattle to fatten them.

In this section, as in Adams, Berks, Cumberland, Franklin, Lancaster, Lebanon, Lehigh, Northampton, York and other counties, a corn stalk should be developed that will grow and ripen the longest ear with the largest number of rows of grains five-eighth of an inch long that can be produced within the limits of the season. Every two acres of this land will produce, with a rotation adapted for the purpose, a sufficient amount of grain and roughage to feed one dairy cow for one year. Such a rotation and succession of crops can be arranged to suit conditions and the purposes for which the crops are to be used, whether for dairying, for fattening cattle, for making baby beef or for hogs. Along the Swatara are some strips of meadow land some of which need underdrainage, but whether needing underdrainage or not the soils of these lowlands are among the most productive in the county.

LOWER SWATARA TOWNSHIP

This township lies west of Derry and Londonderry with the Susquehanna River for its western boundary. The soils of the township are derived from the Trenton limestone, the Mesozoic red shale, the Utica and Hudson River shales, and the gravels and sandy formations along the Susquehanna River or river bottom lands. The river land extends with considerable width from the Swatara which forms the southern boundary of the township with gently rolling land to the northern limits of the township.

The soils are gravelly, sandy and loamy with similiar adaptations to soils of similiar derivations previously discussed in connection with Londonderry township. East of these river soils the Mesozoic red shale crops out and becomes the basis of the soils with similiar capacities and adaptations to those referred to in eastern Londonderry township immediately across the Swatara. A narrow strip of limestone soils crosses this township having similiar capacities and adaptations to the same type of soils discussed in Derry township lying east of Swatara. In the northwestern corner of the township and extending through Swatara to the river is quite an extensive section the soils of which are derived from the Utica and Hudson River shales. The strata from which these soils are derived are composed of grey, red and sandy shales which give their color and character to the soils. The strata are composed very largely of the grey shales and, therefore, the larger area of soils is derived from these strata. The red shale make a deeper more fertile soil than the gray with larger water and fertility holding capacity adapted especially to raising wheat of which it will produce larger yields of a hard red type having better milling quality than the gray shale soils will. The sandy shale and sandstone soils usually occur on the higher elevations and on the ridges along the steeper slopes of the streams. These soils are usually thin with small water and fertility holding capacity not so well adapted for raising the general farm crops, which require the whole summer for their development but adapted for raising fall sown early spring ripening crops such as rye and winter vetch or an early ripening wheat; or, for early spring sown early summer ripening crops such as early peas and early oats. The fertilizer should be applied to these sandy and shaly sandstone soils in the form of stable manure or by plowing down such soil enriching crops as the winter vetch, or wherever it can be successfully raised, crimson clover, the cowpea and red clover sods, because the fertility contained in the organic combination, both in manure and in the crops referred to is made available slowly or in these sandy soils approximately as the growing plant needs it while when the fertilizer is applied in immediate available form these sandy soils do not hold it and what

ever quantity is not taken up by the plant within a short period of time passes beyond the reach of the roots of the growing plant and is of small value. On the uplands between the streams and along the lower slopes of the higher hills in the gray shales disintegration has proceeded further, the soils are loamy and deep with sufficient water and fertility holding capacity to carry such crops as corn through a normal summer drought, while such early summer ripening crops as red clover and timothy rarely suffer from dry weather in these soils. Along the line of contact between the Utica and Hudson River shales and the limestone which makes a narrow outcrop through the northern central part of this township, some low and in occasional places spouty land occurs which needs underdraining to put it in condition to yield the best returns.

Along the same line of contact on the lower, gently and moderately rolling slopes the soils are deep and fertile with large water fertility holding capacity, soils in which the agencies of disintegration are quite operative and in which the fertility contained in the rock from which these soils were originally derived is still made available. These are among the most easily farmed soils in this or any other State, because they plow easily both when wet or dry and they can be farmed wet or dry without injurious effects because they do not contain a sufficient amount of clay to cause them to become compacted and hard and normally the water these soils contain is in the capillary condition ready for the plant to use it. This condition makes these soils warm, because there is little evaporation so that seeding can be done early and provides a congenial environment for seeds to germinate and to grow and also puts the soil in condition for continuous cultivation. Advantage should be taken of these conditions and late fall and early ripening spring crops should be raised so as to utilize the advantages these soils offer both for the production of crops for human nutrition and for the maintenance and the increase of their fertility. On the north side of this valley beyond the more rolling section the land becomes hilly and the soils are washed and unless hillside farming is practised the soils will be washed away and become so thin that crop yields will not be remunerative.

Beside lower Swatara, the soils of all but the north central part of Swatara, which are derived from the limestone, are derived from the Utica and the Hudson River shales and are similiar in formation, capacity and adaptation to the soils of lower Swatara of similar derivation. Swatara township lies north and west of Lower Swatara with the Susquehanna River for its western boundary. The Utica and Hudson River shales form quite a slope along the river land, which as previously indicated washes rather easily and on which hillside farming should be practiced.

The river land is of similiar derivation, adaptation and capacity as similiar soils discussed in connection with Lower Swatara and Londonderry townships, but in this section these soils are largely built over with factories and mills and furnaces of the Penna. Steel Company. As in Lower Swatara, so in Swatara, a narrow limestone valley crosses the township, culminating in a magnificent outcrop of limestone south of Harrisburg.

The following analysis of two specimens of limestone from Rutherford along this valley gives an idea of its composition.
2nd. Pa. Geo. Survey M. M. Page 310.

	East Quarry	West Quarry
Carbonate of lime,	86.125	90.625
Carbonate of magnesia,	8.861	6.167
Oxide of iron and alumina,	.363	.600
Sulphur,	.136	.080
Phosphorus,	.038	.022
Insoluble residue,	4.300	2.508

The soils of this narrow limestone valley are similiar to those of similiar derivation previously discussed.

The following townships north of limestone valley have soils derived from the Utica and Hudson River shales, slates and sandstone, East, South and West Hanover, Lower Paxton and Susquehanna.

EAST HANOVER TOWNSHIP

East Hanover township lies north of Derry and south of Rush, with the Lebanon county line for its eastern boundary. The soils of this township are very similiar to the soils derived from the same formation in the township previously discussed, except that the closer this formation approaches the mountain the more steeply hilly and rougher the land normally becomes until the higher slopes of the Blue Mountain are reached where the soil is derived from the Oneida and Medina sandstone and is of little or no farming value.

Through the central part of this township, the more sandy strata of this formation make the basis of the soils with more sandy though comparatively deep soils especially adapted to raising potatoes, the clovers and the cereal grains. A clover sod should be plowed down to get the best results with potatoes in this soil, therefore, a rotation which includes a clover is of vital consideration with the potato farmers. Usually these soils are sufficiently limy especially along the line of contact between the limestone and the shale to, when well farmed, neutralize all acidity and little lime need be applied except in the low lands where the soils have become clayey and in some in-

stances are spouty. Several small areas of low land occurs along the foot of the mountain with soils derived from the finely disintegrated rock from the mountain side making a fine loamy soil underlaid with clay of such toughness that underdraining is necessary to raise agricultural crops of which when underdrained this soil will produce larger yields than the surrounding shaly soils. If not underdrained this land can usually, with the application of lime and manure, be made to produce such hay grasses as bushy blue stem, red top and sometimes blue grass. It pays to till drain these soils. These soils are usually rather strongly acid.

SOUTH HANOVER TOWNSHIP

South Hanover township lies north of Derry and partly south of East Hanover, with the Swatara Creek for its southern boundary. The soils of this township are derived from the Utica and Hudson River shales and are very similiar in capacity and adaptation to the soils of the township previously discussed, except in the various curves of the Swatara, some lower and more gently rolling land occurs with deep soils with large water and fertility holding capacity adapted especially for raising corn, oats and the hay grasses such as timothy.

WEST HANOVER TOWNSHIP

West Hanover township lies north of South Hanover and east of East Hanover. Along the southern border of the township the sandy formation running through East Hanover and discussed under that township, makes the soils with similar capacities and adaptations. In the central part of this township the Trenton limestone comes to the surface and it, together with the limy Utica shales, forms a fertile soil especially adapted to raising alfalfa and the clovers. It seems that in a soil of such origin after alfalfa is started it should never run out because a sufficient amount of lime is present all the time to prevent any acidity interfering with its growth.

LOWER PAXTON TOWNSHIP

This township lies west of South and West Hanover. The soils of the whole township are derived from the Utica and the Hudson River shales, except in the vicinity of Linglestown, where a similiar limy formation, as described in West Hanover, occurs, with soils of similiar adaptations and capacities and in the northwestern corner of the township where a small area of the lowlands discussed in East Hanover township occur with also similiar capacities and adaptations.

SUSQUEHANNA TOWNSHIP

This township lies west of Lower Paxton, with the Susquehanna River for its western boundary. Harrisburg, the Capital of the State, and county-seat of Dauphin county, is situated in this township. The soils of the township are derived from the Utica and Hudson River shales and sandstones, with the exception of the river land, of which there is quite an area extending from south of Harrisburg, which is located on the river land to the northern part of the township and eastward beyond Paxton Creek.

Here, as has been previously stated in connection with Londonderry and Lower Swatara townships, are the best market gardening and trucking soils in this section of the State and, in as far as possible, these soils should be used for the production of these crops. The Utica and Hudson River soils east of the river are more rolling than elsewhere and are more easily farmed but similiar in capacity. Middle Paxton, West and East Hanover and Rush townships have soils derived largely from the same strata. The Blue Mountain divides Middle Paxton from Susquehanna and Lower Paxton.

In several sections along the southern slope of this mountain, some fairly fertile agricultural land occurs with deep soils, derived from the softer Red Medina and Oneida sandstone with comparatively large water and fertility holding capacities, adapted for raising potatoes, buckwheat, rye, oats, wheat, and when limed, the clovers, and among the fruits, the apple.

Between the Blue Mountain and Second Mountain where the soils are largely derived from the Hamilton shale, the portage flags, the Chemung shale and the Catskill red sandstone, the land is hilly and farming attended with difficulties and returns not inviting, but with the markets provided by the coal miners, some of the land throughout this valley is farmed. North of Second Mountain, which is formed of the Pocono sandstone, on both sides of the narrow outcrop of the anthracite coal or top of the Pottsville conglomerate, the soils throughout both valleys are derived from the Mauch Chunk red shale. The land is usually rough and stony along the mountain sides while along the more moderate slopes of the hills and in the valleys the soils are fairly deep, smoother, less stony, with comparative large water and fertility holding capacity adapted to raising timothy hay and buckwheat, and where the limy strata of this formation enter into the construction of the soils, wheat, corn, oats, rye, the clovers, especially the alsike, yield comparatively large crops. Among the root crops, potatoes yield fairly large crops here. Apple trees make a fairly vigorous growth and produce large yields of fair size, well colored and flavored fruit.

Peters Mountain forms the northern boundary of the townships above discussed and separates them from Halifax, Jefferson and Jackson. Halifax township lies along the Susquehanna River with Peters Mountain for its southern and Berrys Mountain for its northern boundary. The soils of this township are derived from the Catskill red sandstone and the Chemung shales. The land is usually hilly and some of it rough and stony, but normally smooth enough for fairly easy plowing and cultivation. The soils are fairly deep—except in the Chemung shales along the river where they are thin and lean—with sufficient water holding capacity to carry an average corn crop through a normally dry season. These soils will, when limed, produce fairly large yields of corn, oats, rye and a hard red high milling quality wheat; and among the clovers, red alsike, and in the deeper soils, alfalfa. Potatoes produce good yields of well developed mealy tubers. Jefferson and Jackson townships, except in the eastern part of these townships, where the soils are derived from the Pocono sandstone, have similiar soils, with similiar capacities and adaptations. Apple trees make a vigorous growth in these soils and produce fairly large yields of well sized, nicely colored and flavored fruit

Upper Paxton, Washington, Mifflin and Lykens townships lie between Berrys Mountain on the south and Mahantago Mountain on the north, with soils derived from the Mauch Chunk shale, making a valley six and eight miles wide and extending from Millersburg eastward into Schuylkill county.

The land is usually hilly with some steep, stony and rough slopes with thin soils, with small water and fertility holding capacity, soils that wash rather easily and, unless it rains frequently, soon become too dry for crops to grow successfully. Besides these formations, at such places as Gratz and Elizabethville, there are large areas of more moderately sloping, well-rounded hills with moderately rolling uplands, with fairly deep soils, with good water holding capacity and fair fertility holding capacity adapted to the raising of wheat, rye, oats, timothy hay, and among the legumes the red and alsike clovers and the Canada field pea, and where the soils are deep enough, alfalfa will thrive. Apple trees make a fairly vigorous growth and produce fair yields of normal sized, well colored and flavored fruit. Fertilizer, especially nitrogen, increases tree growth, fruit yields and enhances color and flavor.

A rotation of crops should be adapted for these soils, in which a soil improving crop should always follow a soil exhausting crop. The winter vetch, the Canada field pea, the soja bean, the red and alsike clovers would lend themselves to such a combination. In this way and by the judicious use of stable manure, these soils would be made to produce twice what they are now producing. It must not be ex-

pected that soils that are derived from the Mauch Chunk red shale can be made to produce as large crops as the soils derived from the decomposition of the Trenton limestone, except the formation contain the limy strata that occur in the western part of Fulton county or in the southeastern part of Perry county where these soils are very productive.

The county is drained in the southern part by the Conewago, flowing along the southern border and the Swatara, flowing diagonally across the south central part of the county, and by smaller streams flowing into the Susquehanna and in the northern part by Fishing, Stony, Clarks, Powell's, Wiconisco and smaller streams. The railroad facilities of the county are fairly good.

LEBANON COUNTY

Lebanon county was formed from parts of Lancaster county, but mainly from Dauphin county, by an Act of Assembly, February 16, 1813. The agricultural operations however began prior to 1720.

Her agricultural resources and well cultivated farms have kept prestige with any in the State, due largely to the skill and industry of the Germans who form nearly all the population.

It contains 230,400 acres, of which 173,593 acres is land in farms, and of which 148,750 acres is improved farm land. 24,480 acres were planted in corn in 1909, yielding 467,814 bushels; 19,751 acres were sown with oats, yielding 526,455 bushels; 33,053 acres with wheat, yielding 621,336 bushels; 4 acres with buckwheat, yielding 40 bushels; 1,966 acres with rye, yielding 29,168 bushels; 2,966 acres with potatoes, yielding 162,893 bushels; 416 acres were planted with tobacco, yielding 405,669 lbs; 40,070 acres were sown with all forage crops, yielding 43,212 tons of the various kinds of hay. At this time Lebanon county had a population of 59,565 to feed, 18,440 cattle, 6,421 horses, 2,258 mules, 15,083 swine, and 586 sheep.

Lebanon county lies north of Lancaster, east and south of Dauphin and west of Schuylkill and Berks. The geological formation from which the soils of the county are derived, begin with the Potsdam sandstone No. 1 and ascend through the Trenton limestone, the Utica and Hudson River shale and slate, the Oneida and Medina sandstone, the Clinton shale, the Lower Helderberg limestone, the Oriskany sandstone, the Hamilton shale, the Portage flags, the Chemung shale, the Catskill red sandstone the Pocono sandstone, the Mauch Chunk red shale, the Pottsville conglomerate into the coal measures. Be-

side these formations, the new red sandstone of Mesozoic Age with its accompanying trap dykes makes the basis of the soils in the southern part of the county.

Londonderry, southern South Annville, southern Cornwall, southern South Lebanon, southern and eastern Heidelberg and southern and eastern Mill Creek townships have soils derived from similiar geological formations.

LONDONDERRY TOWNSHIP

Londonderry township occupies the southwestern corner of the county, with Dauphin on its western and Lancaster county on its southern border. The soil in the southwestern corner of the township are derived from the new red sandstone, above referred to. The land is moderately rolling, except in some places where it approaches the trap dyke which passes along the border between Lancaster and Lebanon counties. Here it becomes hilly.

The soils are deep with large fertility and water holding capacity, adapted to raising all the agricultural crops that will thrive under prevailing climatic conditions, but especially adapted the more moderately and gently rolling for raising timothy hay. This soil, especially the more clayey types, as stated in the discussion of other counties where it occurs, has a great affinity for organic matter and seems to derive more benefit from an application of straw, strawy manures and even corn fodder than from an application of a fair grade of commercial fertilizer, therefore, it should be made an object by the farmers on this land to arrange a rotation by means of which as much organic matter as possible could be applied to these soils.

As previously indicated, a trap dyke passes along the southern border of this township with soils derived from the disintegration of these rock combined with some of the overlying sandstone. This section is hilly, some steeply hilly, with rough and stony and even rocky land, difficult to farm with soils the more steeply hilly, rocky and mountainous especially adapted for growing forests. The more moderately rolling land on the higher elevations and along the western slopes with stony and even rocky soils which do not readily wash are among the specially well adapted peach soils of this section producing large yields of well developed, highly colored, nicely flavored fruit.

Apple trees make a vigorous disease-resisting growth, but do not normally produce as highly colored and delicately flavored a fruit as do trees that are grown where the Potsdam sandstone combines with the Micaceous and sometimes trap rock in forming the soil. The more rolling loamy types of this soil produce large yields of hard red wheat, a splendid type of oats and corn, and among the long season legumes, the red and alsike clovers and alfalfa; and among the short season the crimson clover, the cowpea, the soja bean and the winter vetch.

With an array of crops like these for the raising of which the soils are adapted, soil improving crops could be made to follow all soil-exhausting crops readily. Immediately north of the red shale and sandstone soils, another intrusive dyke of Granitic rock comes up and together with the red shale and sandstone enters into the formation of the soil similar to that along the more rolling section of the formation along the southern border of the township adapted to the same crops.

North of the narrow section of trap and gray sandstone soils, the soils are derived from the red sandstone of the Mesozoic Age, with the higher elevations and along the steeper slopes, having thin, sandy and stony soils, with small water and fertility-holding capacity, which readily become dry, causing reduced crop yields; while on the more gently rolling sections and along the line of contact between the limestone and the sandstone, the soils are loamy and deep, with large water and fertility-holding capacity, adapted for the raising of all agricultural crops that will thrive under prevailing climatic conditions.

SOUTH ANNVILLE TOWNSHIP

This township lies east and north of Londonderry. The Mesozoic red shale and sandstone soils occur in the southern part of this township and are similar to the soils of Londonderry township, occurring along the line of contact between the limestone and the red shale, except that the slopes by which the sandstone rises from the limestone are steeper in most places, and the area of deep, fertile, loamy soils is smaller, while the steeper sandy and stony areas are large with soils that have less water and fertility-holding capacity and wash more readily.

As previously stated, these soils, especially the sandy and stony types, have a strong affinity for organic matter, and devour it in large quantities if supplied to them and are much benefited by it in productive, water and fertility-holding capacity and in preventing washing. An early cool weather crop such as wheat, rye, winter vetch, red, alside or Mammoth clover or timothy hay crop could be harvested and the land sown with a hot dry weather crop, such as cowpeas, these plowed down and the land sown with another early summer ripening crop, and in this way crop yields obtained and the soil supplied with a high type of organic matter from which it derives so much benefit. This same soil formation extends into northern Londonderry township.

CORNWALL TOWNSHIP

Cornwall township lies east of South Annville and Londonderry on the Lancaster county line. As previously indicated, the soils of only the southern part of this township are derived from the sandstone of the Mesozoic Age and the intrusive trap dykes.

What has been said about the soils, their derivation and adaptations in the trap or Granitic and red sandstone formation in the southern part of Londonderry township, applies in the southern part of this township, except that for some distance along the line of contact between the limestone and the red sandstone, the Granitic rock appears and a small section of soils derived from Granitic, red sandstone and limestone rock occurs, with splendid capacity and that more of the red sandstone and the Micaceous shist rock seems to remain than further west, and to make these soils looser, but the steeply hilly, rocky, stony and mountainous configuration adapted for growing forest and the more rolling for raising fruit.

SOUTH LEBANON TOWNSHIP

This township lies east of Cornwall on the Lancaster county line. The city of Lebanon, the county seat of the county, is partly located in this, Cornwall and North Lebanon townships. The land with soils derived from the red sandstone and the trap rock, are located in the southern part of this township, and are similar in derivation, configuration, adaptation and capacity to the soils of southern Cornwall.

HEIDELBERG TOWNSHIP

This township lies east of South Lebanon with the Lancaster county line for its southern boundary. The soils of the southern south central and eastern part of the township are derived from the new red sandstone, except the remanent of Utica and Hudson River shales and slates north of Scheafferstown and Klinefeltersville.

Along the southern part of the township the land is in some place steeply hilly and stony, difficult to farm, with thin soils derived from the more sandy strata of the new red sandstone, with limited water and fertility-holding capacity, similar to those previously discussed; while a little further north the land becomes more rolling with deeper, larger water and fertility-holding soils, derived from the finer sandy strata of the new red formation, the more elevated sections of which are adapted to raising fall-sown crops such as rye, wheat, red clover and timothy, that will ripen before the usual dry weather of July and August comes, when crops usually suffer for water in these soils; while the more moderate slopes and the more gently rolling sections with deep, large water-holding capacity soils will carry crops through as prolonged a

drought as the limestone soils will. Crops adapted to these soils have been previously referred to and need no further comment here. The section of Utica and Hudson River shale land is more hilly than the limestone north of it, but the soil is usually deep with comparatively large water and fertility-holding capacity, especially adapted, the more limy sections of it, to raising a hard, high-milling quality, red wheat. Large yields of a splendid quality of corn is also produced by these soils. Potatoes also find congenial soil conditions here and large yields of a superior type of mealy potatoes are raised in these soils.

MILL CREEK TOWNSHIP

Mill Creek township lies east of Heidelberg township, occupying the southeastern corner of Lebanon county with Lancaster county on its southern border and Berks on its eastern. The southwestern corner of the township has soils derived from the same strata of the new red shale as those occurring along the line of contact and south of it between it and the limestone in Heidelberg township, with similar capacities and adaptations.

The southeastern, eastern and the larger part of the southern section of the township has soils derived from the Potsdam sandstone. Much of the land is hilly and even mountainous, with rough, stony soils not adapted to farming and only fit for growing forests, with which a large part is covered at this time. The less steeply hilly and stony land on the uplands where the Micaceous rock takes part with the Potsdam in its construction, the soil is especially adapted for growing vigorous disease-resisting apple trees that will produce large yields of well-developed, highly-colored, nicely-flavored fruit. Along the lower and more moderate slopes of the hills where the soils are derived from the red sandstone and the Potsdam, and in some instances, the Micaceous rock equally as and even more desirable apple soils occur, especially along the northwestern slopes of these hills.

The more moderately rolling land along the foot of these hills where the red shale and the sandstone form the soils, the land is stony, but productive, while where the soils are derived from the Potsdam sandstone and the limestone, they are among the most fertile, easily kept in productive condition soils throughout these hilly lands, especially adapted for raising a hard, red, high-milling quality wheat and a superior quality of corn and potatoes. These soils will also produce the legumes, such as alfalfa, among the long season crops, and the cowpea, the soja bean, the winter vetch and the Canada field pea and among the fruits, the apple.

The limestone valley of this county is simply a continuation northeastward of the Cumberland Valley, and beginning with the Dauphin county line, extends through northern Londonderry, South Annville, Cornwall, South Lebanon and southern North Lebanon, southern central Jackson, northern Heidelberg and northern and central Mill Creek townships. The land throughout this limestone valley is gently rolling, smooth and easily farmed. The soils derived from the decomposition of this limestone are usually deep, with a water-holding capacity, that if a surface of finely cultivated soil is maintained they will sustain a drought of six weeks in the hottest season of the year and develop, with the water stored up and held by capillary capacity, an average corn crop. This capacity gives these soils an advantage in crop production not possessed by any of the soils throughout this section of the State and consequently an agricultural value not equalled by any soils in this section. Another advantage these soils have, is, that they are not wet, spouty and cold, needing underdrainage; in fact, large areas have natural underdrainage through underground water courses in the limestone.

These favorable conditions do not prevail where the limestone outcrop comes within two feet or a foot of the surface. In such places, the areas of which are limited, the soil becomes dry, and during even a limited drought, crop yields are very much reduced. With these exceptions the conditions above referred to usually prevail. With these natural advantages and with good agricultural practice and by maintaining in these soils large quantity of organic matter derived from clovers it is possible to produce, even with the present rather superior agricultural practice throughout this section, much larger crops than are at present produced, in fact, it is possible to produce on every two acres of this land sufficient roughage and grain to keep one dairy cow for one year or to fatten two steers or to develop two calves so that they will weigh 1,000 pounds in fifteen to eighteen months and make baby beef out of them and at the same time improve the soil.

Crops can be so arranged that a soil-improving crop can follow or precede a soil-exhausting crop and these, together with the right use of the manures, can be made to improve the soils and put them into condition to sometime under normal conditions with agricultural practice, developed so that they will convert the largest amount of the sun's energy into available human or animal nutrition reach the limits of their productive capacity.

North of the limestone valley the soils are derived from the Utica and Hudson River shales and slates. The following townships and parts of townships, beginning with Dauphin county, contain these soils:

North Annville, East Hanover, central and northern North Lebanon, Union, Swatara, Bethel and North Jackson. The strata from which the soils of this formation are derived are composed of gray, red and sandy shales and slates which give their color and character to the soils. The gray shales predominate and therefore the soils derived from these strata comprise the largest area. The red shale usually disintegrates more readily than the gray or sandy shales and, therefore, makes a deeper, more fertile soil, with larger water and fertility-holding capacity, adapted especially to raising the cereal grains, such as wheat, of which it produces fairly large yields of a hard, red type, with splendid milling qualities. Corn and oats yield fairly large crops. So do the legumes, such as the red and alsike clovers and alfalfa.

It seems that the cowpea, the soja bean and the winter vetch should also yield comparatively large returns. The sandy and gravelly soils which are derived from the harder, more sandy strata usually occur along the ridges and at the brow of the hills and on the steeper slopes above where the valleys of the streams are narrow and in such places where the soils have been washed away; therefore the soils may be thin and stony because they have been washed away or because the underlying rock has resisted the agencies of disintegration. These soils can be cultivated early in the spring and spring seeded, early summer ripening crops can be raised, or fall seeded, early summer ripening crops such as rye, winter oats, early ripening wheat and timothy, for the growing of which these soils usually contain a sufficient amount of water at this time. As previously indicated, the gray shale predominates and the largest area of soils is derived from it.

On the more moderately rolling uplands above the streams courses where little washing occurs, the soils are deep with, in many places, clayey sub-soils, with, where these sub-soils occur, large water and comparatively large fertility-holding capacity, adapted to raising all the agricultural crops that thrive under prevailing climatic conditions.

NORTH ANNVILLE TOWNSHIP

North Annville township lies north of South Annville and Londonderry on the Dauphin county line. Along the line of contact between this formation and the limestone, the land slopes up gradually, especially is this true of the Quittapahilla Creek. The soils are deep, with fairly large water and fertility-holding capacity, sufficiently limy, with thorough cultivation to supply all the lime needed by the greatest lime demanding crop, such as alfalfa. This should be an ideal alfalfa soil, and it seems that this crop should have a permanent place in the rotation followed in this section. North of this

section the soils in this township are derived from the gray, red and sandy shales and are similar in structure, capacity and adaptation to those previously described.

EAST HANOVER TOWNSHIP

East Hanover township lies north of North Annville on the Dauphin county line. In the southern part of this township, along the Swatara Creek, is quite an area of lowland, with soils that need underdraining, derived from the local strata, which have been so completely disintegrated that the soils are clayey, but with sufficient sand and gravel that they will not break when underdrained, nor become cloddy when cultivated wet, which makes these among the most productive farming soils of this formation.

In the northern part of this township, along the Blue Mountain, another section of lowland occurs, with soils that are largely derived from the fine clayey materials washed from the mountain side, which, when underdrained, also makes a productive soil, adapted to the raising of wheat, oats, corn to some extent, and timothy hay. With these exceptions, the soils are similar in derivation and adaptation to those previously discussed.

UNION TOWNSHIP

Union township lies east of East Hanover. Its soils are similar to those described in East Hanover township and, therefore, need no further discussion.

NORTH LEBANON TOWNSHIP

This township lies north of Cornwall and South Lebanon and east of North Annville. The soils along the line of contact between the limestone and shale are the same as those discussed in connection with North Annville, except that the slope may be more moderate than further west, and that in the northern part of this township the trap dyke, of which Bunker Hill is formed, produces a narrow section which will be discussed in connection with Swatara township.

SWATARA TOWNSHIP

This township lies east of Union and North Annville and north of North Lebanon. The soils of the township are derived from the Hudson River shales and sandstone, and the trap rock from the trap dyke in the Bunker Hill vicinity, and the Oneida sandstone of Little Mountain.

In the southern part of this township the soils are derived from trap and Hudson River shale rock along the lower slopes and on the more rolling sections, while on the more elevated parts the trap

rock predominates, making, in many places, rough, stony and steeply hilly land, difficult to farm with deep soils which will produce agricultural crops wherever they can be farmed but are much better adapted for raising fruit. Apple and peach trees make a vigorous disease-resisting growth and bear large crops of well-developed, highly-colored, nicely-flavored fruit. In fact, this combination of Utica, Hudson River and trap rock makes the best fruit soil throughout this section, and all that is available should be used for this purpose, especially the more stony and steeply hilly parts, because on this land, with the right kind of management, a soil enriching cover crop such as crimson clover, could be continuously kept growing, except for a few weeks in the early summer, and in this way washing would be prevented and the soil kept in continuous productive condition. The more clayey, less stony and more moderately rolling land, with soils derived from the rocks are well adapted for raising the regular farm crops, such as wheat, corn, oats, timothy, and with thorough cultivation and the application of lime, the legumes, the red and alsike clovers and alfalfa, wherever the soils are not underlaid with a well nigh impervious clay and where the water remains below three feet in the soil.

This same combination of rocks from which soils above described are derived, extends into North Annville and East Hanover townships near to Belleview. Considerable fruit is being raised throughout this entire region, with results that amply demonstrate what can be done. The orchards up to this time have largely been planted on the combined soils and not so much on the trap lands. It seems planting on the latter would bring better results.

North of these combined soils in the vicinity of Jonestown, the soils are again derived from the Utica and the Hudson shales and sandy shales. The land is moderately rolling, the soils are fairly deep, except on the steeply sloping higher elevations where they are thin with small water and fertility holding capacity and therefore, reduced production when rain does not come at the right time.

In northern Swatara and Union townships, along the western terminus of Little Mountain, on both sides of Swatara Creek, is some of the low land derived from the mountain washing or from the local disintegrated fine shale and sandstone, with deep fine loamy soils which need underdraining but when underdrained are the most productive soils throughout this section. Along the northern and western slopes of Little Mountain are some fairly good fruit lands, with deep soils, with sufficient water holding capacity to develope a fruit crop during a comparatively dry season. Along the southern slopes where good air drainage exists, the soil is usually deeper, more fer-

tile and will grow and ripen a more vigorous wood growth, which will yield large crops of a well developed, nicely colored and flavored fruit than the northern and the western slopes will.

Monroe Valley, between Little and Blue Mountain, is hilly and much of the land rough and stony, well nigh all of which should be in forest. In Northern Jackson township along the line of contact between the limestone and shale, previously referred to, the land is moderately rolling, with considerable areas of deep soils derived from the Utica and Hudson River limy shales, with large water and fertility holding capacity, adapted to raising the regular farm crops, but especially adapted to producing large yields of superior quality wheat, corn and large yields of alfalfa for the growing of which this soil has peculiar adaptations.

BETHEL TOWNSHIP

Bethel township lies north of Jackson and North Lebanon on the Berk's county line. The soils of this township are derived, except along Little and the Blue Mountain and north of it, from the same formations previously discussed with similiar capacities and adaptations.

North of the Blue Mountain in northern East Hanover, northern Union, northern Swatara and northern Bethel, the soils are derived from the Clinton shale, which forms the northern lower slope of Blue Mountain, and in Swatara and Bethel townships the Lower Heidelberg limestone, which, however, plays an insignificant part in the formation of the soils in this section. The valleys of Trout Run and Swatara Creek, with soils derived from the Hamilton and the Chemung shales, are hilly, and much of the land is rough and not adapted to farming; while the less steeply hilly and smoother land with comparatively deep soils, with fair water and fertility holding capacity, is being successfully farmed even truck crops and the small fruits are successfully grown in some sections of these valleys, for which a market is afforded in the coal regions. North of this valley and the narrow Chemung ridge, the Catskill form the southern slope of what is known as Second Mountain, in Dauphin county, with the best apple soils in this whole mountain region in the northern part of this county. Potatoes are also successfully grown throughout this formation; so are small fruits and truck crops.

The Pocono sandstone forms Second Mountain, with only small areas of rather poor farming land. North of Second Mountain the Mauch Chunk red shale remains in a valley between Second and Third Mountain, with hilly land along the ridges and steeper slopes of which the land is rough and stony, the soils thin, with small water and fertility holding capacity, while on the rolling upland between

the valleys and along the broader valleys, some fairly deep soils with fair water and fertility holding capacity occur which will produce splendid crops of rye, buckwheat, timothy hay and potatoes, and where the limy strata of this formation occur, the clovers.

In farming these soils, in so far as possible, such soil improving crops that will produce the largest quantity of organic matter should be made to follow soil exhausting crops. It seems that after its introduction, the winter vetch, with some rye and the clover sods which can be raised, would furnish such crops.

DRAINAGE

The county is drained throughout the northern section by the Swatara Creek and its tributaries, which flows into the Susquehanna River. The southwestern part is drained by the Quittapahilla Creek and its branches flowing into the Susquehanna; and the southeastern part by the Tulpahocken, which flows into the Schuylkill River. The railroad facilities of the county are among the best in the State.

BERKS COUNTY

Berks county was named after Berkshire, in England, where the Penn family held large estates, and was formed from parts of Philadelphia, Chester and Lancaster counties, in the year 1752. Agricultural operations, however, began as early as 1704 to 1712 by the early settlers.

Berks county contains 553,600 acres, of which 458,450 acres is land in farms, and of which 381,596 acres is improved farm land. 57,568 acres were planted with corn in 1909, yielding 1,193,332 bushels; 46,289 acres were sown with oats, yielding 1,105,012 bushels; 67,719 acres were sown with wheat, yielding 1,183,320 bushels; 158 acres were sown with buckwheat, yielding 1,664 bushels; 18,294 acres were sown with rye, yielding 257,889 bushels; 10,675 acres were planted with potatoes, yielding 657,214 bushels; 216 acres were planted with tobacco, yielding 199,681 lbs.; 98,770 acres were sown with all forage crops, yielding 108,031 tons of the various kinds of hay. At this time Berks county had a population of 76,530 to feed, 46,613 cattle, 17,380 horses, 4,089 mules, 36,279 swine, 792 sheep.

The county is bounded on the south and west by Lebanon and Lancaster, on the south and east by Chester and Montgomery and on the north and east by Lehigh and on the north by Schuylkill. The geological strata which form the basis of the soils of the county

include the Gneissic, the Potsdam sandstone, the Trenton limestone, the Hudson River and Utica slate, the Medina and Uneida sandstone, the Clinton shales, the Mesozoic sandstone and shales and the trap rock, the latter two forming the basis of the soils of the southern townships. The drainage of the county is accomplished by the Schuylkill River and its tributaries, the Tulpehocken, which drains the northwestern part, except the extreme northwest, which is drained by the Swatara, Maiden Creek flowing into the county from Lehigh drains the northeastern corner. The Little Lehigh River rises in the eastern corner of the county and drains this section. The Monocacy drains the southern central part southward into the Schuylkill, while Allegheny Creek and Beaver Run drain the southern red shale townships northward into the Schuylkill. The soils of the county may be tentatively divided into four sections: The southern or Mesozoic sandstone and shale, the southeastern Gneiss and Potsdam section, the central limestone belt and the northern Utica and Hudson river slate belt.

CAERNARVON TOWNSHIP

This township occupies the southern point of the county with Lancaster and Chester counties for its southern boundary. In the southern corner of the township a Potsdam sandstone ridge, coming in from Lancaster county, extends northeastward along the line between Chester and Berks counties, forms the basis of the soil, which is stony and some of it difficult to farm but splendidly adapted for fruit. North of this formation, the famous Conestoga Valley of Lancaster county begins in which the soil is formed of the Silurio Cambrian limestone with all the natural fertility that these soils possess through Lancaster county. The land is moderately rolling and easily farmed. North of the limestone formation the Mesozoic shale and sandstone forms the basis of the soil.

Northern Caernarvon, Union, Robeson, Brecknock, southern Spring, Cumru, Exeter, Amity and Douglass townships, geologically, lie in the same formation, the Mesozoic shales and sandstones. The south central part of Caernarvon in which the Conestoga Valley begins has already been described.

The topography of the Mesozoic formation in Berks county is very different from that in Montgomery, Bucks and Adams counties. In these latter counties this formation is gently rolling and in many places even flat and needs underdraining, while in Berks and parts of Chester and Lancaster the formation is hilly and in many places stony with some steep and easily washing soils of poor quality.

ROBESON TOWNSHIP

Robeson township lies north of Caernarvon with the Schuylkill River for its northern boundary. The Mesozoic and trap rock form the soils of this township. A narrow strip of soils along the Chester county line is formed of the Potsdam sandstone and is rough and stony and difficult to farm. This soil is especially adapted for raising peaches and apples. Further westward the soils are formed from the same underlying strata or rock as those of the previous township, except that Joanna Heights rises out of the land and forms a rough and stony section.

At Geigerstown is a gently rolling section of this red shale land, of good fertility, especially adapted to raising timothy hay which grows native. Between Geiger's Mill and Beaver Run is a rough and hilly section poorly adapted to farming, but will produce fruit when the trees are well cared for. Westward of this hilly and rough country at Plowville and west of this place the land is gently rolling and the soil deep and productive, formed of the shales and sandstone of the Mesozoic strata, adapted to intensive farming of a high type. From Beaver Run northward to the hills along the Schuylkill River, the soil is derived largely from the Mesozoic conglomerate and sandstones which makes rough and sandy soils not of the best quality. Besides this other formations with rough and stony soils usually of small area, also occur in this section. All this land is very deficient in organic matter, while if this was supplied in sufficient quantity this could be made among the productive agricultural sections of the county. A rotation of crops should be adopted by means of which the organic matter could be supplied and paying crops produced. This soil should not be allowed to lie without a cover crop. Along the Schuylkill River a number of hills such as Gibralter Hill, Cedar Hill, Sheep Hill and others with stony and rough soils derived from the Potsdam sand and some granite occupy the country. Much of this land can be farmed or used for raising peaches and apples. At Birdsboro the trap rock makes the basis of the soil and is as usual well adapted for raising apples and peaches.

BRECKNOCK TOWNSHIP

This township lies west of Robeson on the Lancaster county line. The soil of this township is formed of the same underlying strata as that of Robeson. A rough, stony and hilly area of considerable extent occupies the southeastern corner of the township. The northern part is moderately and some gently rolling with some of the richest Mesozoic soils of the State within its limits. Along the

northern border, the conglomerate forms the soil. In the southwestern part of the township the trap rock comes to the surface and makes a hilly but fertile section adapted to fruit raising.

SPRING TOWNSHIP

This township lies west of Brecknock and Cumru with the Lancaster county line for its southern boundary. The soils of the southern and central part of this township are formed of the Mesozoic shales and sandstone, the trap dykes and the Potsdam sandstone. In the southeastern corner of the township the land is hilly and rough with soils formed of trap and the Mesozoic sand well adapted for fruit growing. This same rough land continues—though the trap does not enter into the formation of the soil—along the whole of the southern boundary and extends into Lancaster county. Some meadow land occurs along Little Muddy Creek in the southeastern part of the township, while further northward on both sides of the same stream beginning in Cumru township and extending through the central part of the township is a hilly section, with soils formed of trap, and further north of the Potsdam sand. All this land is stony and in many places difficult to farm, but with careful farming can be made productive.

Along Swamp Creek are small sections of Mesozoic conglomerate soils which are always stony and gravelly and not very productive, especially when the weather is dry. These soils will produce peaches. At Fritztown is one of the hilly sections. Along the northern slope of the South Mountain, the Postdam makes the basis of the soil with some very rough and stony land which, however, when mixed with some of the limestone lying immediately north of it, makes the best kind of potato and hard red wheat soil anywhere in the State. In fact, all agricultural crops thrive on this soil. The discussion of the limestone soils of this township will be taken up in connection with the townships of the limestone valley.

CUMRU TOWNSHIP

This township lies north of Brecknock, west of Robeson and east of Spring township. The southeastern and a large part of the eastern section of this township has rolling land with soils formed of the Mesozoic conglomerate and sandstone while the central and western part of the township with soils formed of the Mesozoic sandstone and some outcropping of trap, is hilly and in many places stony and difficult to farm.

Apple and peach trees look very thrifty and bear well in these soils. South of Moonsville is one of the hills with these rough and stony soils while north of this town is one of the rolling sections. The

same Potsdam sandstone hills, already referred to in Spring and other townships, occurs along the limestone valley in this township with similar adaptations.

UNION TOWNSHIP

This township lies west of Robeson and northeast of Caernarvon on the Chester county line. The soils of the township are derived from the Potsdam sand, the Mesozoic conglomerate and sandstone with a few trap outcropping. In the southeastern part of the township the Potsdam sand forms a ridge along the line with a stony soil but one that will produce apples and peaches. Further westward and in the northeastern most part of the Conestoga Valley with some low land formed largely of the Mesozoic strata, opens. West of this valley in the northern part of the township is a Mesozoic hilly section with rough and stony land well adapted for growing forests. The southwestern part of the township is largely occupied by the Mesozoic conglomerate with some stony and rough sections as well as some rolling and smoother formations. Through the central part of the township, including Chestnut Hill and extending into Chester county, a ridge passes with rough and stony land, formed largely of the Mesozoic sandstone with a few outcropping of trap which enter into the formation of the soil but do not change its roughness. North of the ridge and on the northern slope of the ridge the soil is formed of the sandstone and some conglomerates of the Mesozoic with some quite stony and hilly sections as well as some smoother moderately rolling and easily farmed and fertile parts. The more gently rolling land is closer to the Schuylkill River beginning in Robeson township which is also formed of the underlying Mesozoic strata, but is deeper, disintegration having proceeded further and made a more fertile and more easily farmed and more productive soil. This is the highest type of Mesozoic soil with the probable exception of the soil immediately along and toward the river, of gently sloping land which is partly the alluvium of past ages and of soil brought down from the higher elevations of the above formation. This is splendid hay and forage crop soil. It is also adapted for trucking and for dairying and intensive farming of a high order.

DOUGLASS TOWNSHIP

This township lies north of Union with the Schuylkill River for its southern and the Montgomery county line for its eastern boundary. The soils of this township are well nigh entirely derived from the Mesozoic strata, except the northwestern corner where the Potsdam sandstone, the Gneiss, the Cambrian limestone and the trap outcrop and enter the formation of the soil. With the exception of a rough

and hilly section in the south central part of the township of the Mesozoic Age the whole of this formation is a moderately rolling country somewhat similar to that of Adams county, and adapted for raising the same crops.

The undisintegrated red shale strata in many places are only eighteen inches and less beneath the surface, and wherever this is the case, the soil soon becomes saturated with water and soon dries out so that in order to produce a large crop, rain must come frequently and in not too large quantities or the fullest productive capacity of this soil cannot be realized. This difficulty can be largely mitigated by plowing down sods and applying manure on the surface and by raising crops for supplying organic matter and plowing these down. These soils have a tremendous avidity for organic matter. This soil will produce in a normal season large crops of timothy hay. It is not strong wheat soil. Toward the northwestern corner of the township, a narrow section of the Cambrian limestone comes to the surface and enters the formation of the soil and together with the surrounding strata, such as the Potsdam sand forming a strong and highly productive soil, adapted for raising all agricultural crops but especially adapted for raising wheat, clovers and potatoes. In the northwestern corner of the township the Potsdam sandstone makes the basis of the soil which is rough and stony, the less stony and more rolling of which will produce peaches and apples.

AMITY TOWNSHIP

This township lies immediately west of Douglass and north of the Schuylkill River. In the southeastern corner of the township, in the vicinity of Douglassville, the soil is very similar to that south of the river in Union township and discussed under that township. Monocacy Hill in the southern section of the township contains, rough and stony land formed from the outcropping trap rock and the red sandstone along its sides, otherwise the southern and central parts of the township are formed of the same series of strata as Amity township to the east.

Along Manatawney Creek is some splendid meadow land adapted to all agricultural crops, but especially for dairying. North of this stream in the northeastern part of the township the same limestone referred to in Douglass township enters into the structure of the soil with similarly good results. In the northern central and the northwestern part of the township the rock known as Potomac marble forms the basis of the soil. This formation contains sufficient lime to justify its use for making agricultural lime. This makes a splendid wheat soil, producing a hard red wheat of superior type and therefore wheat should be continued as one of the crops in the rota-

tion or a rotation should be established in which wheat should occupy the prominent place. This could be made a place for raising seed wheat. Potatoes yield large crops in this soil. All kinds of trees find an especially congenial soil environment here.

EXETER TOWNSHIP

This township lies directly west of Amity township with the Schuylkill River for its southern boundary. The soils of the southeastern and eastern part of the township are formed of the same red shale and sandstone strata as those of Amity and Douglass already discussed. In the central part of the township the trap rock has been raised to the surface and forms the basis of the soil, making a soil of splendid fertility well adapted for peach, apple and grape raising as well as the regular farm crops. The same thing applies where the red sandstone and trap intermingle in the formation of the soil. Directly west of this trap outcrop both the limestone already referred to and the Potomac conglomerate make the basis of the soil with adaptations similar to those stated in the discussion of Amity township. South of the Potomac conglomerate and the trap formations the soil is again formed at this place of the more perfectly disintegrated strata of the red sandstone and shale making a deeper, more fertile and better water holding and productive soil.

Neversink Mountain extends into the western part of this township from Alsace township and makes a rough and stony section not adapted to farming. On the east and north sides of this mountain where the Potsdam sandstone and the limestone unite in forming the soils are some splendid fruit and agricultural soils adapted to the raising of crops already referred to. Gulden Hill in the northern part of the township is another formation similar to Neversink, with surrounding soil formations with similar adaptation. An arm of limestone extends from Olney township into the northern central part of this township with soils formed of the underlying limestone and the surrounding Potsdam sand with similar adaptation as those already discussed. The soils north of the Potsdam ridge surrounding the limestone valley is formed of the Gneiss, is stony, hilly and difficult to farm. Much of this land can be so farmed as to produce fruit for which it seems especially adapted.

Colebrookdale, Earl, Washington, Pike, Hereford, District, Longswamp, Rockland, Ruscombmanor and Alsace townships have soils formed of similar strata and may therefore be discussed together.

COLEBROOKDALE TOWNSHIP

This township lies north of Douglass with the Montgomery county line for its eastern boundary. The rock which forms the basis of the soils of this township are the Gneiss, which covers the central and

the western part, the Potsdam sandstone which forms a hilly section in the eastern central part and the Cambrian limestone paralleling the Potsdam and the Mesozoic sandstone and shale with some trap rock in the southeastern corner of the township. In this southeastern part of the township the limestone, the Gneiss, the red shale and sandstone and the trap rock all enter the formation of the soil producing such a mixture as rarely occurs in so short a distance. This formation extends as far northward as Boyertown and beyond. In the vicinity of this town the trap rock is covered by only a foot or a few feet of the Mesozoic and consequently its effects are noticed on the soil. In other places the Gneiss and trap form the soil and in every case produce soils adapted for raising all farm crops especially wheat but more especially peaches and apples. This seems to have been the—by nature—created fruit section of the southeastern part of the State as the northeastern and some of the northern Catskill and Catskill Chemung soils are of the northern and northeastern section of the State. North of Boyertown along the Montgomery county line, the red shale and sandstone formation of soils continues with adaptations similar to those already indicated.

Throughout the central and western parts of this township the soils are derived principally of the Gneiss and Granittic rock, which means that some of this land is stony and rocky, with some of the uplands, from which the soil has been washed, difficult to farm, while the more rolling, though somewhat stony have a deep soil which retains moisture well, does not readily wash and is not too loose and sandy for the water to sink beyond the reach of the plant roots. These soils are typical eastern wheat, and the deeper and more completely disintegrated types, corn soil, while the more stony uplands and hillsides are specially adapted for peach and apple and grape raising. Potatoes yield splendid returns throughout this section, in fact this crop can be made to pay all expenses incurred in starting a peach and apple orchard until it comes in bearing.

WASHINGTON TOWNSHIP

This township lies north of Colebrookdale along the Montgomery county line. In the southeastern corner of this township the granite comes to the surface and makes a stony section of land with some very elegant fruit soils, while north of this formation the changed red shale forms the soil with sometimes the Granitic rock which evidently produces the change, coming close to the surface. The Mesozoic strata form the basis of the soil which is hilly and again rolling along the entire eastern boundary of this township with adaptations similar to those already given. West of the Mesozoic formation the limestone comes to the surface and it, together with

Potsdam sandstone which has also been elevated into hills, form the soil, which is usually stony but productive, with the adaptations already given. The soils of the central and western part of this township have for their basis the same underlying rock as Colebrookdale with similar adaptations.

HEREFORD TOWNSHIP

Hereford township occupies the northeastern corner of the county, with the Montgomery county line for its eastern and the Lehigh county line for its northern boundary. The Mesozoic strata are the basis of the soils along the eastern section of the township with the same soil types as those of Washington township and with similar adaptations. The Potsdam sandstone and some limy strata enter the formation of the soil along the western border of the Mesozoic making the same types of soil, with similar adaptations as those of the previously discussed townships. The central and western parts of this township have soils derived from the Gneissic and Granitic rock of the same structure, with adaptations similar to the previously discussed townships.

EARL TOWNSHIP

Earl township lies west of Douglass and Colebrook and north of Amity. The southern part of this township is hilly, rocky and stony country with soils formed of the Gneiss and Potsdam sandstone, with a limited acreage adapted to farming. The entire southern part of this township is made up of a series of ten or twelve separate hills with rocky and stony soils derived from the Gneiss and Potsdam sandstone not adapted to agriculture but adapted to timber raising for which a large part of it should be used. Along the hillsides and in the valleys of this section are small areas of soils well adapted to fruit raising and general farming. The same Potsdam sandstone hills extend northward along the western border of the township and form the boundary between it and the limestone valley of Olney township, with a strip of Potsdam sandstone and limestone soils adapted to raising all agricultural crops. The central, northern and northwestern parts of the township have soils of Gneissic and Granitic origin, with the adaptations already given.

PIKE TOWNSHIP

This township lies north of Earl and west of Colebrookdale and Washington townships. The soils of the eastern part of the township are formed of the Gneissic and Granitic rock while through the central part east of Maxatawney Creek, the Potsdam sandstone ridge referred to in Earl township combines along its sides with the Gneiss

in forming the soil. These are among the best apple and peach and grape soils. A similar Potsdam sandstone ridge ranges along the southwestern and western boundary of this township with similar soils and similar adaptations. Between Maxatawney Creek and the western Potsdam hills the soils are derived from the same rocks as those of the eastern section.

DISTRICT TOWNSHIP

This township lies north of Pike and west of Washington and Hereford. The soils of the township are formed of the Gneissic and Granitic rock except in the vicinity of Landis Store where the Potsdam sandstone and the Cambrian limestone outcrop and enter the formation of the soil which have similar adaptation to those of the townships already discussed.

LONGSWAMP TOWNSHIP

This township lies north of District and Hereford on the Lehigh county line. The whole of the southern part of this township lies in the Granitic and Gneissic formation, with the exception of Topton Mountain and the hills north of Rittenhouse Gap, upon which the Potsdam sandstone seems to outcrop producing a soil not adapted for raising agricultural crops but splendidly adapted to forest growth as well as for raising apples and peaches where the land is not too steep and rough for trees to be planted and for fruit to be harvested when grown. Through approximately the central part of the township the Potsdam sandstone forms a range; running parallel with the limestone valley, upon which occur, along the hillsides and on top of the hills, unless table lands of considerable extent are formed, stony soils, while along the lower part of the hills loamy soil of good producing capacity are formed of the disintegrated sandstone. Both hill and hillside soils are splendidly adapted for peach raising.

Along the base of these hills a mixture of limestone and Potsdam sandstone forms among the best potato soils in this part of the State or likely as good as there are anywhere in the State if not better. Some of these soils have produced as high as four hundred bushels potatoes per acre field yields. These are also among the very best wheat soils in Pennsylvania. A rotation of wheat and clover and potatoes makes a splendid combination financially. At long swamp along little Lehigh Creek is a considerable acreage of these soils, with larger and smaller areas all along the contact between the limestone and Potsdam formations. These are also splendid apple soils.

ROCKLAND TOWNSHIP

This township lies west of District and Longswamp, with soils formed of the same underlying strata as Longswamp and with exactly similar adaptations.

RUSCOMBMANOR TOWNSHIP

This township lies west of Rockland and Olney townships. It has a larger area of Potsdam sandstone, along the limestone valley and in the eastern and southeastern sections than the previous township and therefore a larger acreage of rough and stony soil not adapted for raising agricultural crops. In the central part of the township, more rolling land exists formed of the Gneissic and Granitic rock. What has been said of the farming land of Longswamp township applies to this township except that this township has a larger acreage adapted to raising peaches than Longswamp has.

ALSACE TOWNSHIP

This township lies south of Ruscombmanor and north of Exeter. The northeastern part of Alsace and the eastern part of Muhlenburg have soils derived of the Potsdam formation, with Irish Mountain of the Gneissic formation at the curve from where the Potsdam formation changes its course from a northern to an eastern direction. The soils of the central and eastern parts of Alsace township are formed of the Gneissic and Granitic rock, with similar adaptation to those described.

THE LIMESTONE VALLEY

The following townships and parts of townships beginning at the Lehigh county line lie within the limestone valley of this county. Northern Longswamp, nearly all of Maxatawney and Richmond, central Maiden Creek, all but the northern part of Ontelaunee, western Muhlenberg, southeastern Bern, Reading, northern Cumru, eastern and Lower Heidelberg, parts of Heidelberg, and Marion townships. This limestone valley varies in width from about three miles in the Heidelbergs to six miles in the vicinity of Reading and thence northward with an approximate continued width to the eastern limits of the county of between four and five miles. The soils of this valley are derived from the disintegrating strata of the Cambrio Silurian limestone and are clays, loams or gravels, in accordance with the limits to which disintegration has proceeded.

The land is moderately and much of it gently rolling, easily farmed and very productive. The greater part of these soils are loams, with splendid water holding capacity, so much so that with right methods of farming, crops do not suffer much for the summer shower. The

stony soils at the foot of the South Mountain where the Potsdam sandstone and the limestone commingle in their formation has already been referred to. Several small areas of similar gravelly soils in which the gravel is composed of limestone, occur along the Tulpehocken Creek northwest of Reading, another at Temple and still several others in central and southern Maiden Creek township with smaller sections in the other limestone townships of the county. These soils are among the best hard red wheat and clover soils of the section and it seems should be adapted to raising seed wheat and clover seed.

Soils especially adapted for growing seed should whenever and wherever possible be utilized for this purpose. This valley, including Olney township, known as Olney Valley and southern Caernarvon township the soils of which are derived from of the same limestone contain approximately 80,000 acres, every two acres of improved farming land of which will easily produce sufficient roughage and grain to feed a cow for a year. This is the intensive farming section of this county in which there is a large acreage of land that has been farmed for more than a century and a half and which with the methods that have been followed has maintained a productive capacity only equalled in the limestone sections of this State, and which with some changes in the use and application of manure and with the introduction of larger quantities of organic matter into these soils by plowing under heavy sods and by raising short season clovers and with the probable application of some phosphoric fertilizer, can be permanently maintained.

This is one of the milk dairy sections of this State and the land should be used for producing such a succession of crops as will provide the largest quantity of the highest feeding value roughage and grain food as can be produced under prevailing climatic conditions for feeding the largest number of the largest milk and butter producing animals available. This limestone section is now largely devoted to raising the regular farm crops, in the four years rotation of grass, corn, oats, and wheat. Some alfalfa is being raised throughout this valley, usually with good success. It seems that with the soils adapted as these soils are for raising this crop a larger acreage should be grown.

The soils of the townships and parts of townships, lying north of the limestone valley have for their mineral basis the disintegrated Hudson River and Utica slates and shales. Beginning with the Lehigh county line, northern Maxatawney, all of Greenwich, Albany, Windsor, Perry, northern Richmond and Maiden Creek, lying east of the Schuylkill River, have soils derived from these shales and slates. The townships west of the Schuylkill, with soils derived of the same

strata, are northern Bern, Center and Upper Bern, Upper Tulpehocken, Jefferson, North Heidelberg, parts of Heidelberg, and Lower Heidelberg and northern Marion, all of Tulpehocken and Bethel, except the mountainous section. Northern Maxatawney lies within this formation and at such places as north of Kutztown where the underlying limestone comes close enough to the surface to influence the formation of the soil the land is equally as fertile as the limestone soils are and equally well adapted for intensive farming.

GREENWICH TOWNSHIP

Greenwich township lies north of Maxatawney. This is a typical township of this formation containing the shaly and sandy soils so prevalent wherever these strata occur. The land is some moderately rolling, some hilly but little of it too hilly to on account of the hills make farming difficult and unprofitable. On the higher elevations and on the steeper hillsides where the soil has been washed away or where on account of the changed character of the underlying strata the agencies of disintegration have not been as effective the soils are stony, lean and easily effected by dry seasons while where disintegration has proceeded sufficiently to form deep, loamy and sometimes clayey soils they are fertile, not readily effected by drought and are easily farmed. The loamy type of soils throughout this section, especially if some of the more limy strata of this formation enter into their composition, make the best and most productive potato soils of southeastern Penna. These soils also produce some of the hard red varieties of wheat, such as the Harvest King, the Fultzo Mediteranean and likely many other types. A rotation of wheat clover and potatoes should it seems be a financial success in this section. Alfalfa has been raised in many places throughout this formation with fair success. Apples and peaches do well here; peaches in the thinner more sandy and stony types of soil and on the hills, while apple trees thrive better and are more productive in the loamy and somewhat deeper types. Some rough and stony hills not adapted to farming occur throughout this section.

ALBANY TOWNSHIP

Albany township lies north of Greenwich along the Lehigh county line. The soils of this township are very similar to those of Greenwich, with the exception that Blue Mountain, formed of the Medina and Oneida sandstone projects into the central part of the township making a soil not adapted for farming. Northwest of this mountain in the vicinity of Quaker City is a rolling section of land well nigh equally as fertile as the soils at the contact line of the limestone and the shale, otherwise the soils are similar to Greenwich.

WINDSOR TOWNSHIP

This township lies west of Greenwich and Albany. The Blue Mountain formation occupies the entire northern part of the township with little or no farming soil. Along the southern border of this mountain are some stony soils formed of the Medina and Oneida mingled with the Hudson River slates and shales well adapted for fruit raising. In the vicinity of Hamburg some limy strata seem to enter the formation of the soil making a fertile and productive section adapted to intensive farming which is practiced to some extent. The four years crop rotation has been so developed in this vicinity that a clover crop has been raised between every one of the regular farm crops. Southern Windsor and Perry townships are less hilly with a smaller area of rough, stony and sandy land, than Greenwich east of them. Disintegration has proceeded further, and as already indicated, made soils better adapted to agricultural plants. Perry township has a section similar in formation and fertility to that in the vicinity of Hamburg north of Shoemakersville.

Northern Maiden Creek and Ontelaunee townships have soils formed of the Hudson River shale, more moderately rolling and productive than Greenwich township, while at the contact between the shale and the limestone are some nicely rolling and very productive farms adapted to intensive farming. On both sides of the Schuylkill River are some alluvial soils especially adapted, because of their sandy nature, to raising early truck crops, for which there is a great demand throughout this region and for which these soils should be utilized.

Western and northern Bern lies within the Hudson River shale formation with soils similar in formation and adaptation to the soils of northern Maiden creek and Ontelaunee. Southern Center township has an outcrop of the Chazy limestone formation which enters into the structure of its soils and produces a moderately rolling, fertile, adapted to intensive farming section. Along Irish Creek are some meadow soils of splendid fertility. Along the northern border of Center and throughout Upper Bern the land is hilly with numerous sections of soils derived from the more sandy and less easily disintegrated sandstone of this formation adapted for raising such crops as rye, buckwheat and the more hardy clovers such as the Mammoth. The land will also produce peaches, plums and small fruits. This same sandy and hilly formation extends westward into Upper Tulpehocken and northern Jefferson, though less extensive, with usually lower hills, less steep and a larger area of more easily farmed land derived of the same sandy strata and adapted to similar crops.

In central and southern Jefferson, the limestone strata comes sufficiently close to the surface, to make their influence felt in the formation of the soil, making more rolling, more easily farmed and more productive soil, especially is this true of smaller sections where the limestone comes close to the surface. North Heidelberg has a considerable acreage of these soils especially in the southern part of the township. The soils of the remaining sections of the township, except along the northern boundary are formed of the more easily disintegrated shales and are, therefore, deeper, more fertile and more easily farmed than the less perfectly disintegrated. Heidelberg township contains a considerable acreage of limestone soil together with a larger acreage of soil formed of the combined strata of limestone and Hudson River shale both making very productive land. Lower Heidelberg contains a considerable area of Hudson River shale soils in the northern part similar to those of Heidelberg and North Heidelberg, while along the Tulpehocken and north of this stream, the limestone and the limy shales form the soil making a very productive section. The southern sections of these townships have been discussed already.

MARION TOWNSHIP

Marion township lies west of Heidelberg and North Heidelberg on the Lebanon county line. The southern part of this township lies in the limestone section while the northern central part lies in the combined limestone, Utica and Hudson River shale formations with soil derived from these underlying strata with such water holding and making available fertility capacity that ordinarily dry weather does not effect their productive capacity, making this among the most productive sections of the county.

Tulpehocken and Bethel townships occupy, the latter, the northwestern corner of this county and the former lying southeast of it on the Lebanon county line. The soils of these two townships are derived from the Hudson River shales and contain a considerable acreage of the deep clayey soils derived from the more completely disintegrated shales of the Hudson River formation making splendid grass, corn, wheat and oat soils. In the Medina and Oneida sand formation along the side and crest of the Blue Mountain, the best crop to raise are forests, to which about all of this land should be devoted.*

ADAPTATIONS OF THE SOUTH MOUNTAIN SOILS OF THIS COUNTY

The South Mountain region throughout this section has large areas of fruit soils, both peach and apple derived from a mixture of Mesozoic strata, trap and Syenitic exposures and from the intrusive Syeni-

*For a fuller discussion of rotations for the Utica and Hudson River formations the reader is referred to Cumberland county.

tic rock and the Mesozoic, frequently paralleled by the Micaceous and Potsdam formation, all of which formations, except the Mesozoic, make splendid fruit soils; but when intermingled in the formation of the soils, their fruit and fruit tree producing capacity is very much enhanced, as for example the Mesozoic which produces trees of ordinary vigor, while the gravelly soils derived from a mixture of Syenitic and Mesozoic, produces vigorous disease resisting peach trees which have the capacity to throw off and recover from infection with little permanent injury, and at the same time continue producing large crops of highly colored nicely flavored fruit; a capacity also possessed by the soils derived from the trap, Potsdam and the Gneissic. The Potsdam sandstone soils produce strong apple trees, which bear fairly large crops of well colored and flavored fruit, but the trees planted in soils derived from a mixture of Potsdam and Micaceous rock have the vigor to combat the inroads of disease and continue bearing large crops of well developed, highly colored, nicely flavored fruit for a longer time than those planted in soils derived from either one of these formations.

These formations are usually sufficiently disintegrated for apple tree roots to penetrate to such depths that because of the disintegrating processes in these soils they can obtain a sufficient quantity of mineral fertility and moisture, unless the season be abnormally dry, to develop a crop of fruit without the application of water or artificial fertilizer and likely for this reason artificial fertilization has shown little or no benefits. Large areas of these soils are used for raising the regular farm crops which would yield many times larger returns by raising apples or peaches and would continue doing so if a series of soil improving crops were raised by means of which the soil could be permanently maintained fertile. With the development of the fruit industry throughout this section, the cooperative canning and cold storage industry should also be started so that if at any time there should be an over production of fruit or a temporary glutting of the markets the fruit could be held or canned as would seem best, at any rate over-ripe and fallen fruit could be canned.

LEHIGH COUNTY

Lehigh county was separated from Northampton county by Act of Assembly, March 6, 1812. Agricultural operations began as early as 1723, when early settlements were made; but these operations were greatly handicapped by the hostilities of the Indians. It contains 220,160 acres, of which 191,650 acres is land in farms, and of

which 165,662 acres is improved farm land. 23,261 acres were planted in corn, in 1909, yielding 717,987 bushels; 17,352 acres were sown with oats, yielding 391,368 bushels; 28,995 acres were sown with wheat, yielding 518,759 bushels; 307 acres were sown with buckwheat, yielding 5,057 bushels; 15,248 acres were sown with rye, yielding 228,955 bushels; 12,026 acres were planted with potatoes, yielding 1,157,733 bushels; 37, 305 acres were sown with all forage crops, yielding 42,537 tons of the various kinds of hay. At this time Lehigh county had a population of 118,832 to feed, 18,053 cattle, 8,723 horses, 282 mules, 15,203 swine, and 543 sheep.

This county lies south of Carbon, west of Northampton and east of Berks. The soils of Lehigh county are derived from seven different geological formations, the Gneissic and Syenitic and Micaceous schist rock, the Potsdam sandstone, the Silurio Cambrian limestone, including the Trenton calciferous rock, the Utica and Hudson River slates and the Mesozoic shale, conglomerate and the trap rock.

LOWER MILFORD TOWNSHIP

This township occupies the southernmost part of this county, with the Bucks county line for its southern and the Montgomery county line for its western boundary. The soils of the township are derived from the Mesozoic shale and conglomerate and the Gneissic rock with narrow sections of Potsdam sandstone and Silurio Cambrian limestone. The Mesozoic and conglomerate covers the entire western part of the township with the dividing line extending from the northwestern corner of the township, northeastward along Hosensack Creek until, in the central part of the township, the line of contact takes a more direct northeastern course to the eastern boundary of the township.

The land is moderately rolling, some of it hilly, with, where the softer shales occur, deep though rather cold soils, with limited water and fertility holding capacity, adapted for raising all the agricultural crops but especially for raising the hay grasses such as timothy. Where the intrusive trap rock comes to or close to the surface the soils are more fertile and especially adapted for wheat raising and among the fruits, apples. A narrow outcrop of limestone begins at the northwestern corner of the township and extends to the central part along the Mesozoic formation, making deep, warm, loamy soils along the line of contact, adapted especially for raising a superior hard red wheat and large yields of a splendid type of corn as well as the legumes, among them alfalfa. Paralleling the limestone, is a narrow section of the Potsdam outcropping, which, together with the Gneissic formation and the limestone, makes a soil especially adapted for raising the legumes, wheat, potatoes and corn. A rota-

tion of clover, followed with corn with which crimson clover is sown, and plowed down the following spring and the land planted with potatoes, to be followed with wheat and the wheat with red clover or alfalfa and the manure applied with the crimson and the red clovers would, if phosphoric acid is applied with the potatoes and probably with the wheat, not become soil exhaustive and would make three money crops. Through the central part of this township, the Gneissic and the Mesozoic formations unite, and along the line of contact between the two make a soil of peculiar formation but of splendid fertility seemingly having few if any of the bad qualities of the Mesozoic or the Gneissic, with an improvement on their good qualities. Along the line of contact where the Mesozoic lies up against the limestone and where the two intermingle in the formation of the soil in which frequently the Potsdam sandstone joins, occur among the good apple soils of this section of such adapted apple growing fertility that artificial fertilization has produced no effect.

The mixed Mesozoic and Gneissic soils also produce vigorous disease resisting apple and peach trees which yield large crops of well developed, nicely colored, well flavored fruit. The limestone valley of Upper Saucon township, this county, begins in this township and will be discussed in connection with that township. The Gneissic outcrop covers the northern part of this township and becomes the basis of deep, warm, loamy, early spring farming soils which produce all the agricultural crops that thrive under prevailing climatic conditions.

UPPER MILFORD TOWNSHIP

This township lies north of Lower Milford with the Berks county line for its western boundary. The soils of this township are derived from the Gneissic and the Potsdam rock exposures with a small area of limestone in the northern part. The land wherever the Potsdam exposures occur is hilly with deep, stony and gravelly loams splendidly adapted for fruit raising, especially apples, of which these soils will produce vigorous disease resisting trees, yielding large crops of well developed, highly colored, nicely flavored fruit. At Zionsville along the southern border of the township, is such an exposure, including the Feldspatic formation of Potsdam in which tree growth is still more vigorous and probably more disease resisting. This same exposure sweeps round to Shrinersville, and from there east and west throughout the central part of the township and along the line of contact between the limestone and the Potsdam sandstone to Centersville, and west of this place where the Gneissic exposures make a more moderately rolling country, with deep warm

chemically active early spring farming soils with large water and fertility holding, and crop accommodating capacity as will make it possible to take advantage of the entire growing season of the year. This same formation extends from this northwestern section northwestward to Leiperts Gap and from the southeastern corner eastward to the eastern boundary of the township. Well nigh the entire township lies within the, by nature, splendidly adapted peach and apple soils, that will produce vigorous disease resisting trees, which will yield large crops of well developed, highly colored, nicely flavored fruit; every acre of which should be used for raising these fruits. With this naturally adapted soil and climatic environment, such methods of orchard farming and the raising of such soil improving crops should be practiced as experience may demonstrate to be best adapted to maintain the vigor, the disease resisting and the bearing capacity of these trees of large crops of well developed, highly colored, nicely flavored fruit for the longest time, so as to make this a permanent industry.

UPPER SAUCON TOWNSHIP

This township occupies the southeastern corner of this county, lying east of Upper and Lower Milford, with the Bucks county line for its southern and the Northampton county line for its eastern boundary. In the southern part of the township, along the Bucks county line, the soils are derived from the Mesozoic shales, conglomerates and sandstone. The land is hilly, some of it thin and not easily farmed and not very productive, while where the shales prevail, the soils are comparatively deep, loamy soils with poor water but fair fertility holding capacity, especially adapted for raising the same crops as those referred to under the discussion of Lower Milford township in this county. North of the Mesozoic, the soils are derived from the Micaceous and Syenitic exposures. The land is hilly with well rounded hills except along the streams where steep and even precipitous as well as moderate slopes occur. The soils are deep, warm, early spring farming soils with large water and fertility holding capacity adapted for raising all the regular farm crops, but especially adapted for raising apples and peaches as has been outlined under the two Milford townships.

A narrow limestone valley begins southeast of Limeport on the western border of this township and expands as it extends northeastward until it covers the central part of the township with stony and gravelly loams derived along both the north and the south sides of the valley from the combined Potsdam sandstone, the limestone, the Syenitic and the Micaceous exposures making soils that will produce large yields of hard red high milling quality wheat as well as large

yields of a superior corn and the legumes, among which alfalfa should find a congenial soil environment throughout this whole limestone section. Along the north side of this limestone formation, the Potsdam, the Syenitic and Micaceous rock make the basis of the soils with such capacities for apple and fruit raising as have been outlined in connection with the townships previously discussed.

Another thing not stated in the previous discussion and one that as the fruit industry expands as it should and will in these naturally congenial soil and climatic environments, is the building in accessible places of cooperative refrigerating plants, canneries and evaporaters for the purpose of using all fallen and overripe fruit as well as for keeping such fruit for future sale for which there might not be a ready sale when in condition for shipment.

SALISBURY TOWNSHIP

This township lies north of Upper Saucon, with the Lehigh River for its partially northern and eastern boundary. The soils of the township are derived from the Gneissic, Syenitic and Potsdam exposures in the southern part and from the Silurio Cambrian limestone throughout the remainder of the township. The land in the southern part is hilly and much of it stony, but the soils are usually deep and equally as well adapted for fruit raising as the soils of the townships previously discussed and should, in so far as possible with the easily accessible markets be used for raising these crops. The following townships and parts of townships lie within the limestone area of this county: Northern Salisbury, nearly all of Lower and Upper Macungie, all but the central part of South Whitehall, southern North Whitehall, and all of Hanover township lying east of the Lehigh River.

The limestone land in Salisbury township, in the vicinity of Allentown, is hilly with quite an admixture in some sections of the Potsdam sandstone making stony and gravelly loams with complete loams in the more rolling limestone uplands as well as clay soils in the lowland where disintegration has proceeded sufficiently to produce these soils. The stony and gravelly loams as well as the loams are deep and warm early spring farming soils, which when they contain sufficient organic matter and intensive cultivation is practiced can be made to contain from the snows of the winter and the rains of the spring a sufficient quantity of water during dry seasons to produce large market gardening crops as well as corn and potatoes, for the raising of all these crops these soils are splendidly adapted. These soils produce a splendid type of hard red wheat. The legumes especially alfalfa finds a congenial soil environment here. The clay soils which occur largely along the streams produce as large and

even sometimes larger crops of corn than these previously discussed but are not as well adapted for raising alfalfa, wheat, potatoes and early truck crops.

LOWER MACUNGIE TOWNSHIP

This township lies west of Salisbury, north of Upper Milford, with the Berks county line for its western boundary. The soils of this township except in the southwestern part where the Gneissic, Syenitic and Potsdam rock form the basis of the soils with similar capacities and adaptation as the soils of the same origin previously discussed, are derived from the Silurio Cambrian limestone. Along the line of contact between the limestone and the Potsdam sand the soils are a mixture of the two and are stony and gravelly loams, with so large a capillary water holding capacity that they seldom become too wet for cultivation, for as long as forty-eight hours, neither do they become so dry that crops will famish for water in the dryest seasons, especially is this true when surface cultivation is practiced with such crops as corn in which case the stones, gravels and sandy material form a mulch which retards surface evaporation very much.

With a rotation of combined soil improving and soil exhausting crops and perhaps some phosphoric acid the productive capacity of these soils can be permanently maintained. These are among the most productive corn, wheat and potato soils and a rotation of clover followed with corn with which crimson clover and rye are sown sometime in July or August to be plowed down the following spring, the land partly planted with potatoes and soy or soja beans and these two followed with wheat, and the wheat with red clover, or better still, with alfalfa, would make an inviting monetary proposition as well as a soil improving one.

The soils of the remainder of this township are derived from the limestone strata and are deep, except in the limited area where the underlying limestone comes close to or to the surface, the more gravelly and loamy types, warm rather early spring farming soils which usually contain such an amount of fertility as will start fall or late fall sown early summer ripening crops such as rye and wheat among the cereals and vetch, red alsike, alfalfa and crimson clover among the legumes, or early spring sown summer ripening crops, such as the Canada field pea among the clovers and oats among the cereal grains and late spring planted late summer or early fall ripening crops, such as the soy bean, the cowpea, among the legumes, and corn among the cereal grains, with the possibility of having a crop on the soils of all these fields during the winter for an early start the following spring. On soils that will successfully produce such an array of crops it is possible to take advantage of the entire growing season and to arrange a succession that soil improving

crops can be sown with or after soil exhausting crops and in this way with the manures derived from feeding these crops to animals and that used as absorbent and all together with the crops plowed down added, these soils can be made better the longer they are farmed and probably larger crop yields obtained as time goes on. A considerable number of sink holes with some steep and some gently sloping sides occur along the border between the Potsdam and the limestone as well as throughout the limestone formation, indicating that the same agency which was operative in the formation of these limestone valleys is still going on and dissolving the limestone from beneath and furnishing underground water courses for the drainage of these limestone sections.

UPPER MACUNGIE TOWNSHIP

This township lies north of Lower Macungie with the Berks county line for its western boundary. The soils of the township are derived from the limestone and the Utica and Hudson River slates. The limestone land is moderately and some of it gently rolling with the same deep warm, loamy, early spring farming soils with the same large water and fertility holding and crop accommodating capacity as the limestone soils of Lower Macungie. The clayey soils referred to in Lower Macungie along the streams and on the nicely rolling higher elevations occur in this township. These soils usually cannot be farmed as early as the more loamy types but invariably crops grow faster when climatic conditions become more favorable and by harvesting time crop yields on these soils are usually equal to the loamy types and many times larger. Along the line of contact between the Utica and the Hudson River shales and the limestone in the northern part of the township the land rises and becomes more hilly than the limestone with where the limestone and the shales mix in the formation of the soils deep, warm, early spring farming soils are produced equally as productive as the limestone soils, while where the shales and slates make the soils they are thinner wash more readily with a more limited water and fertility holding capacity all of which will be discussed in connection with the township containing these soils. In the western part of this township near the border between it and Berks this shaly formation remains making a more hilly section and producing soils such as have been referred to.

SOUTH WHITEHALL TOWNSHIP

This township lies north of Salisbury and Lower Macungie and east of Upper Macungie with the Lehigh River for its eastern boundary. The soils of the township are derived entirely from the limestone formation except a narrow strip of Utica and Hudson River shales

and slates extending eastward from the northwestern corner of the township and some distance north of Allentown, the county seat of this county, which is located in this township. This section is known as Huckleberry Ridge, with soils on the higher elevations derived from the Hudson River slates and shales in which disintegration has proceeded at such a rate that on the more gently rolling sections the soils have become fine loams and even some clayey material occurs, while on the sides of these moderately sloping hills the gravelly loams occur. The soils upon both the more moderately rolling sections and along the slopes are deep, warm, early spring farming soils with fairly large water and fertility holding capacity in which farming operations can usually begin earlier than on the limestone soils and wherever these soils contain a sufficient quantity of organic matter to make them appreciatively warmer, farming operations can be started still earlier and fall sown early summer ripening crops will make such a start as will put them beyond the effects of early summer dry weather which frequently occurs here.

These are splendid market gardening soils because farming operations can begin ten days or some places two weeks earlier than in any soils throughout this section and the advantage of the early crop higher prices can be gained. Accompanying these hillside soils especially along the northern part of this ridge and north of it are soils derived from various clay outcropping occurring in connection with the iron ore which wherever the clay is not sufficiently mixed with the gravels of the Hudson River formation the soils are poorer, can not be farmed as early and need much more careful handling than the soils derived from the shales and slates previously discussed. The limestone soils of the township are similar with similar adaptations and capacities as those previously discussed except that occasional bluffs and steep inclines of limestone with thin or no soils such as occur along the Jordan and other streams, make a more hilly limestone country not as easily farmed.

NORTH WHITEHALL TOWNSHIP

This township lies north of South Whitehall with the Lehigh River for its eastern border. The soils of the township are derived from the limestone and the Utica and Hudson River slates and shales and the iron ore clays. These clays, wherever the disintegrated rock of limestone and the Hudson River slates has mixed with it in sufficient quantity, the soils are usually more fertile and adapted to and will produce large yields of a superior quality of corn, wheat and potatoes than where the soil is derived from the clays or the Hudson River shales alone. The same is true of the legumes. The limestone land is more hilly in this township than the township

further south but naturally the soils are equally as fertile but because of the steeper slopes some washing takes place, the soils are not as deep, contain a smaller quantity of organic matter and farming is more difficult and cannot be as well done.

It seems that wherever such sections occur, an effort should be made to raise such crops as alfalfa, which would hold the soil and at the same time improve it and the alfalfa, followed with crops which are good soil holders and soil improvers. On the south flank of the Slate Hills, the limestone comes up as high as 550 feet while the limestone valley is only 450 feet above tide. These soils are a mixture of limestone slates and shales and are deep, loamy, warm, large water and fertility holding and fertile soils, splendidly adapted for raising the cereal grains, especially wheat and corn. The yields are not as large as in the limestone valley, but the quality is superior. The legumes thrive well here, especially alfalfa and red clover, so do potatoes, and a combination of alfalfa, corn, wheat and potatoes should be an inviting financial as well as a soil improving proposition; large areas of these soils are well adapted for market gardening, and with the market to consume all that can be produced this business could be and is being made remunerative here.

HANOVER TOWNSHIP

Hanover township lies east of the Lehigh River and directly east of Allentown. The soils of the township are derived from the limestone, except in the southwestern corner, where the Lehigh River changes at right angles from a southern to an eastern course. Here the Micaceous, Syenitic and Potsdam exposures make the soils with similar capacities and adaptations as those of the southeastern townships, previously discussed. The limestone section of this township is moderately and some gently rolling with deep loamy and clayey soils, with large water and fertility holding capacity, the loamy adapted for raising the cereal grains and the legumes, especially alfalfa, while the clayey have similar adaptations, but can usually not be cultivated as early as the loamy types, but will produce as large or even larger crops because of their better fertility and water holding capacity. All of which has ben discussed in connection with the limestone soils of the township on the west side of the river. A number of sections of alluvial soils occur along the Lehigh River at such places as Whitehall, Hokendauqua and at Allentown where the Jordan Creek flows into the Lehigh. These soils are derived from the alluvium brought down by the river and are fertile and adapted to intensive farming and trucking for which a considerable area is used.

HUDSON RIVER SLATE HILLS

The Hudson River slate hills, beginning west of Whitehall, which is situated along the Lehigh River, rise to a height of 610 feet above tide, which two miles further westward, north of the limestone valley, is continued in a series of hills ranging from 610 to 650 feet above tide, while at Balliottsville the hills rise to 680 feet, and one mile west of Ironton to 630, and at Schnecksville one mile west of the limestone valley the height of the hills range from 640 to 720 feet above tide, while the limestone valley is only about 450 fet above sea level.

Huckleberry Ridge, the soils on the sides of which have been discussed, contains a narrow top of slates which ranges from 580 to 650 feet above tide. The same condition continues westward, as at the spur which projects into the limestone valley, in Upper Macungie, a short distance east of the Berks county line, the top of which rises 640 feet above tide, while the isolated knob in the western part of this township, the soils of the side of which have been discussed in connection with Upper Macungie township rises 610 feet above. This demonstrates what has previously been asserted of the rising of this formation above the underlying limestone and the formation of more hilly land, especially is this true of this county. The soils of the following townships beginning with the Berks county line are derived from the Hudson River shales and slates: Weisenberg, Lynn, Lowhill, Heidelberg, Washington and northern North Whitehall.

WEISENBERG TOWNSHIP

This township lies north and northwest of Upper Macungie, along the Berks county line. The soils are entirely derived from the Hudosn River slates and shales, with the high elevations previously referred to occurring at the projections of this formation into the limestone valley. Where the limestone projects into the Utica and Hudson River formation, the land is more moderately rolling, with deeper, loamy, warm early farming soils in many places equally as fertile as the limestone soils, and can be cultivated much earlier giving crops the advantage of the large amount of moisture usually present in the soils in the spring and by the excessive presence of which the soils are not materially harmed and crop growth is not much retarded. The soils of the rolling uplands derived from the shaly strata of this formation are comparatively deep with only fair water for fertility holding capacity adapted especially for raising a hard red wheat of which, among the cereals, they yield fair crops.

Potatoes also find a congenial soil environment and yield as large or even larger crops than any soils in southeastern Pennsylvania. Manure and plowing down of clovers seem to be the most effective

fertilizer for this crop in these soils and in order that the fertility of these soils might be maintained and even improved it will be necessary that a rotation be worked out so that heavy clover sods can be raised and plowed down and large quantities of manure made and applied during the growth of the sod to be plowed down. Decomposition of organic matter usually goes on very quickly in these soils therefore as soon as the land is prepared, the potatoes or whatever crop is to be raised should be sown or planted so as to be sufficiently developed to take up the fertility as it is made available by the decomposing agencies, and again through the plant be put into organic compounds as food for humanity or for animals or for material to be added to the soil for its food.

At Seipsville, in the southern part, at Hynemansville in the western, at Seiberlingsville in the northwestern and above Lyonsville in the eastern are such soils. Wherever the sandy strata, which do not yield as readily to disintegration occur, the land is more hilly and the rather rolling upland stony, with thinner soil, with limited water and fertility holding capacity not so well adapted for potato or wheat raising but fairly well adapted for raising rye. These soils as well as those previously discussed can be cultivated wet without any harm resulting from it and, therefore, crops can be sown or planted at times when the farmer is obliged to wait, during a wet fall or spring season for other soils, while these can be prepared for crops and crops planted or sown and in this way the results of dry weather probably evaded.

It seems that fairly profitable returns should be realized by raising winter vetch and crimson clover seed as money and soil improving crops. The vetch or crimson clover seed could be harvested and the sod disked up and the land sown with northern grown cowpeas and these used for hay for cows or as pasture for hogs and in the fall plowed down and the land sown with rye for a grain crop and this followed with alfalfa or one of the clovers and after the clover potatoes. It seems by working out a succession of this sort, the land could be improved, washing largely prevented and monetary returns realized.

LYNN TOWNSHIP

Lynn township occupies the northwestern corner of this county with Berks county on the western and Schuylkill on the northern boundary. The soils of the township are very similar to those of Weisenberg except that the land is not so steeply hilly throughout this township and the soil is better adapted for raising potatoes and more of the crop is raised not only for this reason but also because of better shipping facilities. The succession of crops usually followed by these farmers is grass preferably clover and timothy of

which the first crop is harvested for hay and the second crop plowed down and the larger acreage planted with potatoes and a smaller with corn, after the potatoes are taken up the land is sown with rye or wheat usually rye and the part planted with corn is sown with oats the following spring and after the oats with clover sometimes with wheat and then with clover. The rotation, as is readily seen, is such that a large acreage is usually available for planting with potatoes, but it is equally evident that it is not soil improving, but rather soil exhaustive, and some improvement along this line should be made by raising more soil improving crops such as have been previously suggested in the rotation.

Sluggards Ridge comes into this township from Berks, the soils of which are derived from a more sandy strata of this formation making a deep sandy loam on the more rolling surface of the ridge with rather large water and fertility holding capacity making wherever these soils occur a better potato soil than the others of equally as high elevations with soils derived from different underlying rock. These soils will produce the legumes and such a rotation should be established that both can be raised and the land improved. At New Tripoli and east and north of this place is one of the more moderately rolling sections, with deep, loamy, warm soils.

HEIDELBERG TOWNSHIP

This township lies east of Lynn with the Carbon county line for its northern boundary. The soils of the township are derived from the same geological strata, as the township previously discussed, with similar capacities and adaptations, except that the land is more hilly throughout the eastern and central sections than in Lynn township.

LOWHILL TOWNSHIP

This township lies south of Heidelberg, west of Weisenberg and east of North Whitehall. The land in this township is hilly with some very steep hillsides along Jordan Creek which flows through the township in a winding course. Some of the hills, as has been previously indicated, rise as high as 720 feet above tide in this township or approximately 300 feet above the limestone valley to the east of the township. Much of the land on the narrow upland is rocky and stony and difficult to farm and, when farmed, does not yield as inviting returns as should be had for the work done in farming it. The soils are fairly fertile and fruit and forest trees make a fairly large growth during dry seasons while only a short time of dry weather will reduce the yields of farm crops materially therefore these soils are better adapted for fruit and forest growing than for farming. A large acreage of these hills and hillsides have been planted with

peach and apple orchards. The apple and peach trees are thrifty, vigorous growers and produce fairly large yields of well developed, nicely colored and flavored fruit and larger returns are realized than from the agricultural crops in the rich limestone valley to the east. A mulch is maintained on the soil by growing cowpeas; these freeze during the first frost and are allowed to remain on the soil during the winter. In the spring this organic matter is disked or plowed into the soil and the operation repeated. More of this land should evidently be planted with fruit.

WASHINGTON TOWNSHIP

This township lies east of Heidelberg and occupies the northeastern corner of this county, with the Lehigh River for its eastern and the Carbon county line for its northern boundary.

Northern Whitehall township will be discussed in connection with this township. The soils of Washington and northern Whitehall are derived from the same rock strata as those previously discussed and are adapted for raising the same crops both fruit and agricultural.

Between Schnecksville and Neffsville some of the rolling upland sections occur. Alfalfa has been and is being raised successfully at this time on these soils, which are sufficiently deep and loamy and warm for this crop to make an early start and produce a large crop of hay early in the season as well as develop and extend its root system at this time and be better able to withstand the usual dryer weather during the summer season. Alfalfa seeding should be allowed to remain at least three years in these soils. On the rolling upland south of Slatington and north of Schnecksville, in Washington township, is a considerable area of deep warm early spring farming soils derived from the shales of this formation splendidly adapted for potato, wheat corn and alfalfa raising as well as such crops as the soja bean, the Canada field pea and crimson clover. With such an array of crops that will thrive under prevailing climatic conditions, a rotation can be arranged so that soil improving crops can be raised with or following the soil exhausting crops.

Northward toward Slatington the country becomes more hilly, until the valley of Slatington, with its steep hillsides, is reached and the whole country is hills except in the central part of the valley, and here litle farming is done. North of the Hudson River slates along the southern slope of the Blue Mountain the soils are derived from the debris of the mountain and are usually rocky, stony and rough with only here and there sections sufficiently clean of stone for farming or fruit raising. Some fruit especially apples are raised in this section and from what has been done and is being done it is

evident that apples can be grown successfully on the less stony and steeply hilly sections, along the southern slopes of this mountain throughout the county.

DRAINAGE

The county is drained by the Lehigh River and its tributaries, among the largest is the Jordan which rises in the Blue Mountains and flows in a southeastern direction and enters the Lehigh at Allentown and the Little Lehigh which drains the southeastern section and flows eastward into the Lehigh also at Allentown. The northwestern corner is drained into the Schuylkill River.

MONTGOMERY COUNTY

Montgomery county was originally part of Philadelphia county, and was erected into a separate county in 1784; but settlements were made and agricultural operations begun as early as 1682. It contains 309,760 acres, of which 251,751 acres is land in farms, and of which 222,636 acres is improved farm land. Thirty-six thousand three hundred and seventy-six acres were planted with corn, in 1909, yielding 1,178,902 bushels; 16,993 acres were sown with oats, yielding 416,127 bushels; 21,653 acres were sown with wheat, yielding 418,635 bushels; 42 acres were sown with buckwheat, yielding 569 bushels; 10,336 acres were sown with rye, yielding 161,476 bushels; 5,643 acres planted with potatoes, yielding 334,124 bushels; 5 acres were planted with tobacco, yielding 7,210 lbs; 65,106 acres were sown with all forage crops, yielding 96,838 tons of the various kinds of hay. At this time Montgomery county had a population of 169,590 to feed, 31,111 cattle, 13,734 horses, 340 mules, 18,956 swine, and 2,485 sheep.

Montgomery county lies east of Berks and east and north of Chester, Delaware and Philadelphia, west of Bucks and south of both Berks and Bucks counties. The geological formations from which the soils in this county are derived, beginning in the southern part of the county, are the Gneissic, which prevail in the vicinity of Philadelpha, followed northward by Syenite and Granite and trap formations; the Silurio Cambrian limestone, which runs northeastward nearly through the county and parallels the Gneissic and Granitic formations; the Potsdam sandstone which parallels the limestone valley; the Mesozoic sandstone and shale from which two-thirds of the soil of the county is derived, parallels the Potsdam sandstone and the limestone valley, and the small sections of Granitic intrusions in the northern part of the county.

LOWER MERION TOWNSHIP

This township lies west and north of Philadelphia county and between the Schuylkill River on the east and Delaware county on the west. The soils of the township are derived from the disintegration of the Granitic, Gneissic, Shistose and other metamorphic rock. Disintegration has proceeded to such an extent that well nigh all the land is moderately rolling, with soils of such depth and so free from stones of any size that farming operations can be carried on with little difficulty except along the streams, where these have cut deeper into the underlying rock and have made ravines with more or less steep slopes; wherever such conditions prevail the land is usually stony, the underlying rock close to the surface and farming attended with some difficulty. On some of the uplands above these streams disintegration has not proceeded sufficiently to make deep soils and therefore on some of these elevations the soil is thin and sometimes stony. But normally, as already indicated, this land is moderately rolling, the soil deep with splendid water and fertility holding capacity adapted to all the regular agricultural crops as well as for raising potatoes, apples, peaches and the small fruits. Wherever possible, the more stony and rocky sections—of which, as already indicated, there are a number along the slopes and on tops of some of the hills—should be used for raising fruit especially peaches, while the rolling clean of stone land should be used for intensive farming of the highest order possible. Much of the land of this township, because of its closeness to Philadelphia and its scenic topography is so valuable for residential purposes that a large acreage has passed into the hands of land speculators who are holding and selling it from $500-$5,000 and more or is owned by men of great wealth who have converted a large part of it into parks and country estates and are not using it for agricultural purposes. With all this increase in value a considerable area of this land is still profitably farmed and will be for some time to come.

UPPER MERION TOWNSHIP

This township lies northwestward of Lower Merion and has the Schuylkill River for its northern and eastern boundary and Delaware and Chester counties for its southern and western boundaries. In the southern part of this township the soil is formed of the sandy and Mica shist rock and disintegration has not proceeded sufficiently to make good agricultural soils.

The land is hilly, with mostly steep slopes, with thin soils adapted for forest growing for which much of this land should be used, unless it could be converted into friut land by terracing, which might, so close to the city, be made a paying proposition. Accompanying this

formation, both on the north and south sides of the ridge, is an area of less steeply hilly land derived from the same underlying rock, but which is more readily acted on by the agencies of disintegration and therefore the slopes are more moderate, the soils deeper, with larger water and fertility holding capacity and are adapted to raising the regular farm crops. North of this section, in the vicinity of Conshohocken, both on the east and west sides of the Schuylkill River, the soil is derived from the Micaceous limestone and is equally as fertile as the limestone soil north of it. But the town of Conshohocken covers approximately the whole of this formation and, therefore, little of it is farmed but wherever crops are raised on this soil its capacity is demonstrated. North of these formations is the limestone valley coming in from Chester county and extending eastward to the Schuylkill River and beyond. The soils of this valley are derived from the underlying limestone strata, except where the rocks of the formations north and south of the valley intrude into it and form hilly, and sometimes stony land, with soils derived of these underlying rock. The land in many places is gently rolling most of it easily farmed, with deep soil, with large water and fertility holding capacity adapted to the highest type of intensive farming either dairying or the more loamy types of of soil for trucking. Two crops could be raised each year in this soil and both could be used for feeding the dairy herd, one the summer crop of corn and such clovers as the soja bean or adapted varieties of cowpeas for silage and grain, followed with a winter crop of Russian or hairy vetch, and rye made into hay, followed with Canada field peas and oats, and the peas and oats with alfalfa, which will make three or four cuttings annually in this section. It seems that with such a succession, the dairy industry could easily be increased to more than twice what it now is. North of the limestone valley, westward from Norristown, are a series of hills, with soils formed of the Potsdam sandstone and a conglomerate of this age, some of which is splendidly adapted to raising peaches and early truck crops as well as for general farming; but tree crops are the crops that seem to thrive best on this soil and return the largest yields. Between these formations unless they are close together the soils are formed of the Mesozoic sandstone and shale which will be discussed later.

PLYMOUTH TOWNSHIP

This township lies directly east of Upper Merion, with the Schuylkill River flowing between the two townships. The northern part of this township lies within the Mesozoic sand and shale formations, which will be discussed later, while through the central part, the Potsdam sandstone, with its associated conglomerate, forms a series of hills with soils which in some places are stony but are productive,

adapted to the production of such crops as were referred to in the discussion of the same formation in Upper Merion township. Through the south central part of the township, the limestone, already referred to in Upper Merion township, forms the basis of the soil, with equally as large and diversified a productive capacity as that of Upper Merion. The southern part of this township, with soils formed of the Micaceous limestone, was discussed in connection with the same formation in Upper Merion. In the central part of this township is a section of clay soils derived from the Syenitic rock adapted to raising the regular farm crops better than any other.

WHITEMARSH TOWNSHIP

This township lies east of Plymouth, with Philadelphia county for approximately half of its eastern boundary and the Schuylkill River for the southern. The soils of this township are derived from the Gneissic and Granitic rock in the southern part, the Silurio Cambria limestone in the central part and the Potsdam sandstone and Gneissic and Granitic rock in the northern part. In the southeastern corner of the township the soil is somewhat sandy and along some of the inclines that are rather steep the soil is thin and not productive. This land could be made more productive by plowing down such crops as cowpeas raised after a crop of hay had been cut early in June and after the cowpeas are plowed under, a crop of rye and Russian vetch making a still better clover crop could be raised, and in this way the vegetable matter could be increased in the soil as well as its productive capacity, and still at the same time be made to furnish a rye and Russian vetch hay or silage crop and a cowpea pasture crop for hogs. The Micaceous limstone soils also extend into this township and are similar in formation and crop adaptation to the soils of Plymouth and Upper Merion townships. Barren Hill and Lafayette Hill have sandy and stony soils, derived from the Potsdam sandstone, better adapted to fruit raising such as peaches than for raising the regular agricultural crops. The limestone soils are the same as those of Upper Merion and Plymouth and are adapted to the same intensive farming as are the soils of those townships. North of the limestone valley, the sandy rock of the Mica shist formation makes a ridge, with sandy and stony land, which, if handled, as previously suggested, for the more sandy and hilly southeastern section can be made productive. In the northwestern part of this township, the Granitic, the Gneissic and Potsdam sandstone, with an occasional admixture of rock of Mesozoic Age, form the basis of the soils, which, in some places, where the more easily disintegrated rock prevails, are moderately rolling and adapted to raising agricultural crops, while where the sandstone and Granitic rock prevail the land is stony, more steeply rolling and adapted to tree and fruit raising.

SPRINGFIELD TOWNSHIP

This township lies directly east of Whitemarsh township, with Philadelphia county for its southern and part of its eastern boundary. The central and northwestern part of this township lies in the Silurio Cambrian limestone section of this county with soils derived from these strata with the same productive capacity and adaptation as those of the limestone soils already referred to. In the limestone section of this township is located the Fifteen Acre Flourtown Farm on which was produced enough roughage, annually, and sometimes some of the grain, to feed thirty dairy cows and two horses required to do the farm work. There are thousands of acres in the limestone section of this county and in the sections of a number of the counties in the southeastern and in the central parts of this State, in which the soils are derived from this same limestone that are naturally equally as fertile as the soil of the Flourtown farm which can, by applying similar agricultural methods, be made equally as productive. On this farm the best developed methods of constructive farming were practiced. The crops were harvested when they contained the largest quantity of the most easily digested and evenly balanced nutritive rations that crops will contain throughout their development and were housed in this condition and through the vital machinery of the animal, converted into the largest quantity of available human nutrition, while the waste material was immediately put back into the soil factory to be made into more fertility to produce more highly nutritious crops to be made into more human nutrition. The southern and southeastern parts of this township lie in the same formation as Lower Merion township and have soils derived from the same underlying rock with similar adaptations.

Cheltenham, Abington, except the north central part, and all of Moreland townships, except the northern and northeastern parts, have soils derived from the Granitic, Micaceous and Gneissic rock.

CHELTENHAM TOWNSHIP

Cheltenham township lies east of Springfield township with Philadelphia county for its eastern and southern boundary. The land in this and the adjoining townships above named is moderately rolling with deep soils derived from the easily disintegrated rocks, already enumerated, with large water and fertility holding capacity, easily farmed and adapted to successfully raising a larger variety of agricultural root, truck and fruit crops than any soil in this or any other township in the State.

A large area of the nicely rolling deep soils of this and Abington, and Moreland townships are splendidly adapted to the dairy industry because alfalfa, the soja bean, the cowpea and the Canada field pea

all produce large yields of forage, and the soja bean and cowpea large yields of beans and peas so that both a high protein roughage and a high protein grain food can be produced here. These legumes should be more extensively grown so as to raise on the farms of this section both a well balanced roughage and grain ration for the dairy. The limestone valley already discussed enters this township in the northeastern corner and extends northeastward nearly to the eastern boundary with equally as fertile soils as those of Springfield and adapted to the same agricultural practice. A ridge of Potsdam sandstone, beginning in Cheltenham township, extends along the south side of the limestone valley through Abington, into Moreland township with stony soils, adapted better for raising fruit than agricultral crops.

The following townships and parts of townships have soils derived from the brown and grey shales and sandstone of the Mesozoic formation: Northeastern Moreland, northeastern Upper Dublin, Horsham, eastern Whitpain, the whole of Montgomery, eastern Hatfield, a large area of Franconia, with areas scattered throughout Lower Salford, Upper Salford, Frederick, New Hanover, Douglass, Limerick, and upper Lower Providence. Northern Moreland and Horsham townships lying northeastward from Horsham on the Bucks county line have nicely rolling land, with deep, easily farmed soils, derived from the grey and brown strata of the Mesozoic shales and sandstones, adapted to raising the general farming crops, but especially adapted to raising wheat, of which, with careful selection of seed and varieties, these soils can be made to produce a superior type of hard red wheat.

Large areas of the deep more sandy types of soils are adapted for trucking and early market gardening crops. These soils will produce large yields of potatoes of good quality. A rotation of wheat, clover and potatoes with a certain acreage of alfalfa and corn for feeding animals to make manure would, it seems, make an inviting agricultural proposition. Another operation it seems that could be made to yield inviting returns is that of raising seed wheat and clover seed on parts of these farms in connection with potatoes. A succession of crops could readily be worked out by means of which this could be accomplished. Farms for raising pure highly developed and well adapted seeds of all the legumes and the cereal grains, for the various climatic and soil conditions of the State should be established on soils adapted for this purpose. Northeastern Upper Dublin has the same soils as the two previously discussed townships. Throughout the central part of this township the land is more hilly with some sections of soils derived from the Potsdam conglomerate. These soils can be used for raising the regular farm crops but will yield larger returns

by raising the crops already referred to in the discussion of Upper Merion and Plymouth townships. Certainly it must not be understood that all these soils have similar adaptations because throughout this entire section are lowlands, some of them spouty, needing underdraining, that with present agricultural practice will not produce wheat or clover of a common order to say nothing of a highly developed type.

Montgomery and eastern Hatfield, also lying along the Bucks county line, have soils derived from the same underlying rock with similar adaptations as those already discussed. At Hatfield, in Hatfield township, is one of the low spouty sections above referred to with a clayey soil which, with drainage, can be made to produce the superior types of wheat, previously discussed, as well as large yields of the hay grasses such as timothy and among the clovers, the alsike and the common red. Southern Franconia, in the vicinity of Souderton, has some of the soils derived from the grey shales and sandstone of this formation. Through central Franconia and through central Lower Salford the soils are of similar derivation with similar adaptations. In Frederick, New Hanover, and Douglass townships, in the northwestern part of the county, where these same underlying strata form the basis of the soils, the land is more hilly than in the previously discussed townships, with thinner, more sandy and stony soils, with less water and fertility holding capacity. From the steeper hillsides throughout this section the soil has been continuously washed so that on many of them little soil remains and therefore crop yields are low and financial returns not inviting. Wherever the land is rolling and disintegration has proceeded sufficiently to form deep soils, these are equally as fertile as those of the previously discussed townships; but the areas are much smaller. In Limerick, Upper and Lower Providence, wherever these same underlying strata form the basis of the soils, the more hilly formation prevails with similar conditions, but with more fertile soils, especially along and at some distance away from the streams. Throughout this western region a considerable acreage of the land has been planted with peaches and apples and some splendid fruit crops have been raised. Some of these orchards, which have yielded their owners rich returns, are located near Royersford, in Upper Providence and Limerick townships. The trees look thrifty, have made large growth but apparently do not possess the intensive vigor so evident in the trees growing on the deep forest soils of the combined Granitic, Potsdam, Gneissic and in some instances Shistose rock.

All this vigor probably can be furnished by the use of fertilizer and green and animal manures. Nearly the whole of Whitpain, Norriton, Worcester and Towamencing townships, together with eastern

Perkiomen, eastern Upper and eastern Lower Providence have soils derived largely from the red shale of the Mesozoic Age. North of the Potsdam sandstone and conglomerate in southern Whitpain and northwestern Norriton townships and lying up against it along the hills is the Mesozoic red shale. Usually where the two formations come together, the land is stony and difficult to farm, but trees, especially fruit trees, thrive better in the smoother soils of the combined formation than they do on the red shale alone. West of Ambler are several hills of the Potsdam sandstone forming a hilly section, with the sandy and rougher soils; while between this and the Potsdam formation to the south along the limestone valley the land is moderately rolling with soils derived from the red shale.

The central and northern and western parts of this township have soils also derived from the Mesozoic red shale and sandstone. The land here is generally moderately rolling, in many places gently rolling, especially on the upland away from the larger streams, and in such places where the underlying rock has yielded more readily to the agencies of disintegration. Where disintegration has been interfered with by underlying strata of less easily disintegrated rock the soil has been washed away and the land is stony, and in such places, steeply rolling, the soils are thin, with small water and fertility holding capacity and agricultural operations do not yield inviting returns. But usually these areas are not extensive.

Some of the more moderately rolling sections, where the slopes are such that washing away of the soils takes place slowly, are underlaid with sandy strata which do not yield readily to disintegrating agencies, upon which the soils are thin with small water holding but with large fertility holding capacity, soils that are too wet for farming operations with only the normal amount of rainfall in the spring and usually too dry during the hot months of the summer in a normal season for crops to make yields such as these soils are capable of producing when the rainfall happens just at the right time. When only a normal quantity of organic matter has been supplied to retain sufficient moisture during the hot month of the season, to keep the soil cooler and moister and dryer and warmer during the cool and wet seasons the yield of crops is wonderfully increased; with soils formed under such conditions the supply of organic matter must be kept up and a crop rotation adopted that will continuously provide this material in sufficient quantities. These soils will usually produce a larger yield of timothy hay than any other crop. A crop rotation adopted to making timothy hay and timothy seed the major money crops can easily be worked out for these soils.

In moderately rolling areas where disintegration has not been interfered with by harder underlying strata and where there has been little or no washing the soils are comparatively deep, with good water and fertility holding capacity and are fairly productive. Such a section occurs in the vicinity of Washington Square. This land will produce the regular farm crops in well paying quantities but with the introduction of organic matter of a high type, these soils would yield returns that were likely only equalled when they were first farmed. The cereal grains on these soils are not equal in quality or quantity to those produced on the grey shale soils of this formation. As already indicated, in the case of the moderately rolling land underlaid with strata that have not yielded to disintegration; so these soils have a wonderful hunger for organic matter and with that hunger only partially satisfied they will yield much larger crops than they now do. Rye usually makes a fair crop on any except the spouty soils of this formation. Under climatic conditions as they exist here and with rye as a money crop, it seems that an early variety of cowpeas, could be made a crop to return a high type of organic matter to these soils; raised after the rye is harvested and plowed down at the beginning of Septemeber and the land sown again with rye or wheat and grass especially timothy. This operation could be tried on a small scale and if it works out it could be extended, and if not another and better adapted process could be worked out.

What has been said here about the soils of Whitpain and northern Plymouth townships, is true of eastern Norriton. While through the central part of this township small areas of Gneissic and Granitic formations crop out and enter the formation of the soils, making the land more productive, adapted to a larger variety of agricultural and horticultural crops. In the northwestern corner of the township the land is more hilly, with soils that will be discussed later. This same more hilly formation extends eastward through Worcester township, lying north of Norriton, while the western part of this township has soils of similar derivation to those already described in Whitpain township.

TOWAMENCING TOWNSHIP

Towamencing township, lying north of Worcester, is well nigh entirely within the red shale formation, with more moderately rolling land than any of the previously discussed townships and likely more land that needs underdraining. The wet and boggy sections, when underdrained, make the most productive soils of this formation, yielding large returns of all the cereal grains and the clovers especially the alsike and the common red and the hay grasses, especially timothy. Eastern and northern Lower Providence and northern and northwestern Upper Providence have soils of similar derivation, with

land that is more hilly than in Towamencing and some other sections farther east. In the vicinity of Collegeville, in northern Upper Providence township, are characteristic formations of deep and productive soils with good water and fertility holding capacities also of thin soils with poor water but good fertility holding capacities, the former producing splendid returns for the good agricultural treatment they are receiving, while the latter under similar treatment do not yield by any means as satisfactory returns. The more hilly land with soils derived from the red shale prevails throughout this western section of the township, while in other parts of the township the land of this formation is more rolling.

Still more hilly and stony land derived from the rock of the Mesozoic Age which has been changed by the head of the igneous intrusive rock from beneath which, in most places does not come to the surface, but in others comes to the surface forms the Granitic ridges such as the Ringing Rock, referred to later. These soils are largely confined—with the exception of a narrow strip in the central part of the county extending from opposite Phoenixville in Chester county in a northeastern course well nigh across Montgomery county— to northern Franconia, Upper Salford, Marlboro, Upper Hanover, northern Douglass, central Frederick, northeastern Perkiomen, Lower and Upper Pottsgrove.

In northern Franconia and in southern Upper Salford the land is moderately rolling, with usually well rounded hills with soils, which, though sandy and in some places stony, are productive and adapted to such crops as rye, buckwheat, potatoes, the clovers, and when supplied with a sufficient quantity of organic matter, will produce inviting crops of wheat, corn and oats. Along Rich Valley Creek are some small sections of good farming land. But where the Granitic outcrops appear north of this stream, the land is very rough and not adapted for raising agricultural crops. But the less rocky and smoother sections will produce apples and peaches, and in this way frequently will yield larger returns than the best sections of the county do in agricultural crops. Central Marlboro lies in the same formation as northern Upper Salford and therefore has similar soils with similar adaptations. In Upper Hanover township the soils of the hills and ridges if such may be termed are usually derived from the strata that have undergone changes by heating from beneath and which because of this heating or on account of the sandy character of the rock have resisted the agencies of disintegration and have formed thin sandy and stony, difficult to farm and unproductive, soils while the brown and grey shales, which also occur here, have yielded more readily to these agencies and have, therefore, become the source of deeper, less stony, more easily farmed and productive soils. These more

stony soils will produce apples and peaches and it seems if this land would be planted with peach trees and sown with cowpeas sometime in June and these cut up with a disk harrow sometime early in September and the land sown with crimson clover or Russian vetch and rye and these plowed under or cut up with a disk in the spring that the washing of this land would be prevented and the soil brought up so that by the time the peaches have run their course, the soils would be sufficiently fertile for a previously planted apple orchard to thrive. In this way it seems returns could be gotten out of the rougher sections of this land such as are not now obtained. The less stony and more sandy soils of this formation are adapted to raising the cereal grains, and with a rotation of crops arranged in such a way that a high type of organic matter can be added to the soils these crops will return much more satisfactory yields than they now do. Such a rotation has been suggested in connection with the discussion of the sandy soils of the red and grey shales.

DOUGLASS TOWNSHIP

Douglass township lies west of Upper Hanover on the Berks county line. The northeastern corner of this township lies in the same formation as Upper Hanover, with soils of similar adaptations.

UPPER POTTSGROVE TOWNSHIP

Upper Pottsgrove township occupies the northwestern corner of the county with soils derived from the changed strata of the Mesozoic sandstone and here, as was stated in the discussion of Berks county as well as farther northward, are the apple and peach soils of the southeastern section of the State and as large an acreage of these rougher soils should be utilized for producing these fruits as could be made available with such methods of keeping up the fertility of the land as will assure a permanent industry as far as fertility is concerned. In Lower Pottsgrove the land derived from this formation is hilly, but some of these soils are deep and will produce cereals well and should be used for raising these crops as well as the crops already indicated. As previously indicated, the soils derived from the rock of Mesozoic Age which has been changed by the heat of igneous intrusive rock from beneath has made more stony land, so wherever this intrusive rock has come to the surface the land in most places is still more stony, rocky and hilly and is generally adapted to less exacting crops than the regular farm crops. The formation of the soils derived from the intrusive rock begins in the southeastern corner of Frederick township along both sides of the Perkiomen Creek and divides into two arms, one extending westward to the Berks county line and the other northwestward to the Lehigh

county line. At Perkiomenville, this northwest arm divides into two branches, one as already indicated, extending northwest and the other eastward to and beyond the Bucks county line.

The three divisions of this formation have sections in eastern and southern Frederick, northern Upper Salford, southern Marlboro, eastern and southwestern New Hanover, northern Upper Hanover, southeastern Douglass, northwestern Limerick and eastern Upper and Lower Pottsgrove. The soils derived from these rocks are rocky, stony, sandy and frequently where the soils derived from the heated Mesozoic sandstone and the igneous rock come together disintegration has proceeded sufficiently far to make clayey soils. At Ringing Rock, in Lower Pottsgrove township, are characteristic rocky, stony, gravelly, loamy, and to the west of this place clayey soils. In this section where the land is so stony that it would be impossible to plow, fruit trees have that vigorous appearance so manifest wherever the igneous rock forms the basis of the soil or where it only partly forms the basis. The loamy soils derived from the disintegration of these rocks, though small in area, will produce splendid crops of hard red wheat of good milling quality. These soils will produce large crops of potatoes, clover and corn, but are better adapted for raising wheat. A rotation of clover, potatoes and wheat on the loamy soils, with the hay grasses on the clayey types, with fruit on the rocky and stony types, should make an inviting agricultural and horticultural operation in this section; but as previously stated, Ringing Rock is only a sample of a large number of similar formations throughout the townships, above enumerated, and shows that a large acreage of these various types of soils exist throughout this formation adapted for raising the crops already indicated. With the markets that exist throughout this section of the State for both fruit and potatoes, every acre of this land that could be put into condition for producing these crops should be utilized. Trolley and railroad facilities for shipment to the surrounding towns and cities as well as to Philadelphia, are available so that with the right kind of city connections there should be no trouble to dispose of all the crops that can be produced. The fruit industry is still in its infancy throughout this section, only here and there have orchards been planted. But wherever these have been started and have been properly cared for results have been such that the question of failure is a negligible quantity.

DRAINAGE

The drainage of this county is accomplished by the Schuylkill River and its tributaries, flowing from the north, which forms the boundary between this and Chester county, except in the southeastern part. The land of a considerable area of the southeastern part of this

county has been farmed for more than a century and a half, and with farming operations conducted as suggested for these soils, will produce as large and even larger crops than have been produced.

BUCKS COUNTY

Bucks county was one of the three original counties established by the founder of Pennsylvania in 1682. The first settlement within the present limits of the county were made by the Swedes, as early as 1670. It contains 389,120 acres, of which 352,928 acres is land in farms, and of which 298,126 acres is improved farm land. Forty-one thousand nine hundred and sixty-nine acres were planted with corn in 1909, yielding 1,942,444 bushels; 23,690 acres sown with oats, yielding 576,130 bushels; 28,077 acres with wheat, yielding 539,181 bushels; 1,050 acres with buckwheat, yielding 17,563 bushels; 13,752 acres with rye, yielding 202,597 bushels; 8,745 acres were planted with potatoes, yielding 752,888 bushels; 2 acres with tobacco, yielding 2,291 pounds; 88,657 acres sown with all forage crops, yielding 123,884 tons of the various kinds of hay. Of the 298,126 acres of improved farm land, 211,942 were used for raising farm crops, while 86,184 were not used and were likely producing weeds. At this time Bucks county had a population of 76,530 people to feed, 35,022 cattle, 16,255 horses, 401 mules, 24,477 swine, and 2,154 sheep.

This county lies southeast of Lehigh, east of Montgomery, north of Philadelphia, with the Delaware River for its eastern and southern boundary. The soils of this county are derived from the Gneissic rock, the Potsdam sandstone, the Silurio Cambrian limestone, the Philadelphia and Manayunk schist, the Mesozoic red and grey shales and sandstone, the trap distributed throughout the Mesozoic formation, the Welden clays, the red and yellow gravel and clay, the Trenton gravel and river mud along the Delaware. The county extends from the South Mountain, on the border of Northampton county on the north to opposite Burlington, New Jersey, a distance of thirty-three miles along the Delaware River, throughout which distance the soils are derived from the formations above enumerated; but largely from the Mesozoic red and gray shales and sandstone, with largely gently and some moderately rolling land, with soils of various capacities and adaptations, as will be indicated under the discussions of the various townships.

FALLS TOWNSHIP

This township occupies the southeastern corner of the county, in the curve of the Delaware River where it changes from a southeastern to a southwestern course. In this curve of the river is an elevation

known as Turkey Hill, with soils derived from the Welden clay, together with gravels and clays of later ages. These soils are deep and fertile and adapted for raising dairy and truck crops, and should be used for this purpose. Surrounding Turkey Hill, the soils are derived largely from the gravels and alluvium, with some low and clayey sections, that need underdraining, which, in some instances, is difficult because of the level condition of the land, and in other places it is underlaid with an impervious clay of such uneven configuration that it is impossible to drain out the water from depressions and from behind what appear to be undulating clay ridges.

With these exceptions, the land normally slopes away from the river, with soils, while they have large water holding capacity, do usually not remain cold and wet for a long time in the spring of the year or begin early in the fall to become uncongenial to plant growth, but may be classified as furnishing a rather warm, comparatively early spring and late fall congenial soil condition for plant growth during a long season. These soils extend to the escarpments beginning in the northeastern corner of this township, at Morrisville, and extending in a southwestern course to Bristol, in Bristol township. North of these escarpments the soils are derived from a coarser gravel known as the Trenton gravel, but still mixed with sufficient loam, silt and clay to give soils large water and fertility holding capacity, but not enough to make them wet and cold and unfriendly to early and late crop growth not even as much so as the soils previously discussed, and adapted for raising truck and all the agricultural crops, as well as for raising the crops to feed the dairy herd or for other lines of livestock industry.

North of this section the soils are derived from the underlying Micaceous rock, together with debris brought by the Delaware River from the formations, through which it flowed, when likely its channel, instead of rounding the curve above referred to, extended from Morrisville to Tullytown. The land is moderately rolling, with deep, warm, early spring farming soils, with fairly large water and fertility holding capacity. Crops should at all times be kept growing on these soils to take up the fertility, as it is more available, and built up into plant tissue so as to prevent it from being carried down into the soil beyond the reach of the roots of the majority of growing plants. Corn and wheat, among the cereal crops and winter vetch, and the crimson clover, among the short season, cool weather clovers, and the red, alsike and alfalfa, among the long season legumes, will all serve this purpose during the late fall and early spring, while the cowpeas and the soja or soy beans, among the short season, hot weather legumes, and corn among the cereal crops, will serve this purpose during the hot and dry season. The Potsdam sandstone forms a ridge

along the northern border of the township, with numerous outcroppings of the rock which makes some stony land with a considerable amount of loam mixed with the stone, making, where the stones are not too numerous, a comparatively deep soil with sufficient water holding capacity to produce a large crop of well developed, highly colored, nicely flavored apples, for the production of which these soils seem especially adapted. In the northeastern and the northwestern corner of the township, north of the Potsdam sandstone ridge, and south of this ridge along the Delaware River are small areas of Syenitic exposures which enter into the formation of the soil, and, together with the Micaceous rock, makes splendid fruit soils, as well as among the best wheat soils of which they will produce large yields of a high milling quality. Corn and the legumes will also thrive here, especially when lime is applied. These soils become sour rather easily, which needs to be corrected every five or six years by the application of from twenty to forty bushels of burned lime per acre.

BRISTOL TOWNSHIP

This township lies west of Falls township with the Delaware River for its southern boundary. Much of the land of this township is level and gently rolling, similar to that of Falls, with deep, loamy, some places sandy, silty and clayey gravels in the southern part, derived from the same formation as the soils of Falls township, with large water and fertility holding capacity, with large areas adapted for dairying and for raising truck crops. The escarpment, referred to in Falls township, as extending in a southwestern course, enters this township and one approximately follows Mill Creek, while others follow parallel courses, dividing in a rather indefinite way these soils from those to the north of the escarpments, which are derived from the underlying rock, and the debris brought down by the river during earlier stages, than the soils to the south. North of Mill Creek the Syenitic rock also takes part in the formation of the soils which are deep with large water and fertility holding capacity, adapted for raising the crops enumerated under Falls township, and for raising fruit and market gardening crops.

BENSALEM TOWNSHIP

Bensalem township lies west of Bristol, with the Delaware River for its southern boundary, and the Philadelphia county line for its western. The land, like that of the two previously discussed townships, is level and gently rolling, with deep, loamy, sandy, silty and clayey gravels, in some places wet, especially the clayey types along the southern part which need underdraining wherever possible, while the other types are usually sufficiently dry for farming operations

to be started comparatively early or sufficiently early for these soils when they receive the agricultural treatment such as thorough cultivation, the application of manure and the incorporation of organic matter so essential in all soils, but to which these soils respond with greater alacrity than most other types, and because of the readiness with which these soils respond to such treatment crops planted or sown in them will make as much growth as those sown or planted several weeks earlier, in less responsive types. These gravely types of soils extend north beyond the central part of the township where the underlying rock and the debris, referred to in the township previously discussed, in a limited way enters into the structure of the soils which are deep, with splendid water and fertility holding capacity, adapted for raising all the regular farm crops, as well as, for dairying and trucking. The Potsdam sandstone ridge crosses the northern part of this township with comparatively deep, sandy and stony loams, splendidly adapted for raising apples, of which they will produce vigorous disease resisting trees which yield large crops of well developed, highly colored, nciely flavored fruit.

Along the northern flank of the ridge, only in a limited way, the Syenitic combines with the Potsdam in the formation of the soils, while further north and extending into Southampton township, the soils are largely derived from the Syenitic rock adapted, the more stony and rocky types, for fruit raising, and the gravels and loams for raising all the regular farm crops and truck crops. The soils of these southern townships of Bucks county, as well as the eastern part of Philadelphia and Montgomery counties, seems to be especially adapted for growing vigorous garden seeds, as well as the legumes, such as the alsike clover, the cowpea, the soja bean, and probably alfalfa. These parts of Bucks and Philadelphia counties are sufficiently far north to put the northern vigor so manifest in all well developed northern grown seed into these seeds, for which there is a constantly increasing demand throughout this entire State, as well as the Southern states. Some seed, especially garden, is raised at this time throughout this section.

These soils, with the treatment previously indicated, are sufficiently sandy, loamy and silty to grow, without vigor, decreasing hesitancy, a vigorous plant which will produce and ripen large yields of vigorous seeds, at least such are the indications from what is being done in this section at this time. A crop of crimson clover seed sown during the previous fall can be ripened, followed with a crop of early ripening soja beans or cowpeas in one season. A crop of winter vetch seed can be grown and ripened, followed with a crop of cowpeas to be plowed down and the ground again sown with vetch for seed. An experienced seed grower will be able to arrange

crops so as to get the largest returns, and at the same time improve the productive capacity of his soils. It seems from some experience, that two crops of alfalfa seed could be raised in one season. Northern grown cowpeas, soja bean, crimson clover and alfalfa seed is in demand at this time, and as farming methods are improved, there will be more and more demand, and in order to foster these advanced agricultural methods, soils that are adapted for producing vigorous disease resisting seeds of the various agricultural crops should be sought out and in so far as possible, be used for raising these seeds.

LOWER WAKEFIELD TOWNSHIP

This township lies north of Falls township, with the Delaware River for its eastern boundary. The soils of the township are derived from the Syenite, the Potsdam sandstone, the Mesozoic sandstone, and the alluvial deposits. The Potsdam sandstone forms the ridge along the southern border of the township, with rather deep Micaceous sandy soils, splendidly adapted for apple and peach raising, of which it produces vigorous, disease resisting trees, which yield large crops of well developed, highly colored, nicely flavored fruits. North of the Potsdam and between it and the Mesozoic, the soils are derived from the gravels, the Syenitic rock combined with both the Potsdam and the Mesozoic, making the more stony and rocky types among the best peach soils in this section. The soils of the township north of this ridge, except along the river, and for some distance west of it where the alluvium combines with it in their formation, are derived from the Mesozoic sandstone with deeper soils than normally occur in this formation, because of the alluvium, except where the sandstone come close to the surface, having fairly large water and splendid fertility holding capacity, adapted for raising all the regular farm crops, but especially timothy hay of which these soils will produce, when manure is applied, large yields of splendid quality. Wherever the alluvium deposits unite with the underlying rock in their formation, the soils are deeper and far more fertile, and adapted to raising corn and wheat, of which they produce large yields of high milling quality. The legumes also thrive here, and among them alfalfa, a crop that does not thrive in the red sandstone unless it is broken up by the underlying intrusive rock or by disintegration.

MIDDLETON TOWNSHIP

This township lies west of Lower Wakefield and north of Bristol. The land in this township is moderately, and in some places gently rolling, with some hilly land along the Potsdam and Syenitic ridges. The soils are derived from the alluvial deposits, the Mesozoic strata,

the Mica schists, the Potsdam sandstone and the Syenitic rock. The combination river gravel debris and Micaceous soils occur south of the Potsdam ridge extending from Chub Run to Oxford Valley. The soils are deep, loamy, silty and clayey gravels, comparatively warm, fairly early spring farming soils with splendid water and fertility holding capacity, adapted for raising all the regular farming crops. At Langhorne, in this formation, one of the dairying sections of this county, is located with soils especially adapted for this kind of farming. The soils are a gravelly clay, especially adapted for raising corn of which they have the general tendency, that of producing enormous stalks, frequently at the expense of an ear comparable with the size of the stalk, and if comparable, the ear usually does not ripen, a tendency to be encouraged in a corn grown for silage, but when raised for corn this tendency must by breeding be diverted to the production of a stalk of such size and character as will produce an ear containing the largest quantity of corn that can be ripened within the limits of the normal season. This breeding work should be done in this section, because if done here a permanent tendency for the development of a stalk that will produce and ripen an ear containing the largest amount of corn can likely be established. The legumes thrive equally as well as corn and, therefore, such a succession of leguminous crops, together with corn and other grains should be established as will furnish a high proteinous roughage to balance the low proteinous corn roughage, together with a sufficient quantity of a high proteinous leguminous grain feed to balance the low proteinous corn grain feed in order to obviate the purchase of large quantities of expensive high protein feeding stuffs. Along the northern border of this formation, the Potsdam sandstone, with soils of similar capacity and adaptation as those of similar derivation previously discussed, occur. North of the Potsdam and between it and Mesozoic, the Syenitic rock, together with the debris previously referred to, as well as some Mesozoic rock, take part in the formation of the soil, producing soils adapted for raising wheat, of which they yield large crops of high milling quality. Some small areas of land occur here that need underdraining. The Mesozoic soils will be discussed later.

SOUTHAMPTON TOWNSHIP

This township lies northwest of Bensalem and west of Middleton on the Montgomery county line. The land of this township is gently rolling, except along the southern part with soils derived in the extreme southwestern part from the Micaceous rock, along the entire southern border from the Potsdam sandstone, followed further north by a belt of soils derived from a mixture of Potsdam

and Syenitic rock along the Potsdam formation, and of Mesozoic strata and Syenitic rock at the line of contact of these two with a belt of soils between them derived from the Syenitic rock alone. The Syenitic rock is harder and does not yield as readily to the agencies of disintegration as the adjoining formations, both to the north and to the south, and, therefore, a ridge is formed known as Bucks Ridge, which evidently reached its highest elevation at Feasterville, in the central part of the ridge, as it passes through this township. This ridge extends between the Neshaminy and Pennypack creeks. The land is hilly in some sections, but mostly moderately rolling. The more hilly sections are splendidly adapted for fruit raising, while the more moderately rolling sections will produce the regular farm crops especially corn and wheat and wherever lime is used, the clovers. The soils derived from these rocks are naturally deficient in lime, and the loamy, but especially the clayey types of soils, become sour and chemically inactive when lime as the carbonate does not exist in the soils, and chemically inactive soils do not furnish a congenial soil environment for the clovers or the agricultural plants. Likely the limestone existing about a mile west of Neshaminy Creek and about the same distance south of the line of contact between the Mesozoic and the Syenitic rock would when finely ground, supply all the lime needed throughout this section. The line of contact between the Mesozoic and the Syenitic formations in this township is well defined in the eastern part by an escarpment along Mill Creek, while further west the line of demarkation is not so well defined the formations intermingle more in the structure of the soil, making soils more fertile than the Mesozoic alone. Along the line of contact, and in some places overlying the Syenitic, is a conglomerate of Potsdam Age which readily disintegrate and makes a gravelly, warm, early spring farming soil, which, when disintegration has proceeded sufficiently far, so as to produce an amount of loamy material to fill up the spaces between the finer gravels, these soils have a splendid distributive water holding capacity, and they are so open that plant roots can readily penetrate in all directions and to great depth, and get water and fertility.

The soils derived from the larger gravels are not equal to those derived from the finer. In the northern part of the township the soils are derived from the Mesozoic gray sandstone and shale strata. The land is mostly gently rolling, with an occasional ridge, underlaid with the more sandy formation. The soils, wherever the gray shales prevail, are deep, rather warm, early spring farming soils, with large water and fertility holding capacity, adapted for raising all the regular farm crops; but especially adapted for raising wheat,

of which they will produce large yields of a hard, red, high milling quality. Corn and the legumes also thrive in these soils and will produce large crops. Potatoes find a most congenial soil environment here, and yield large crops of mealy types.

Besides these crops, these soils can also be profitably used for raising truck crops and when handled in such a way that the fertility is being maintained by a judicious method of crop successions, and the use of manure, with an occasional application of lime, large returns can be realized from such crops, and are being realized from these crops at this time. Large areas of these soils are especially adapted for the livestock industry, and with a succession of crops, both of the soil improving and the soil exhausting, arranged in such a way as to take advantage of the entire growing season, and adapted to climatic and soil conditions, and for the purposes for which the crops are to be used, enough can be raised to feed more than twice the number of animals fed here at this time. These soils belong to the crop accommodating types, large areas of which occur in Delaware, Chester, Lancaster, York, southeastern Adams, Franklin, Berks, Lehigh and Northampton counties, as well as smaller areas in the majority of the remaining counties of the State, especially such counties as Washington, Fayette and Westmoreland, Huntingdon, Center, Blair, Northumberland and Montour.

NORTHAMPTON TOWNSHIP

This township lies northeast of Southampton and north of Middletown. The soils of this township are derived, except in the northern part, from the same strata as those of northern Southampton, with similar capacities and adaptations. In the northern part of the township the red shale and sandstone strata prevail, with soils derived from these strata which will be discussed later.

NEWTOWN TOWNSHIP

Newtown township lies east of Northampton, north of Middletown and east of Lower Wakefield. The soils of this township, in the southern part, are derived from the same underlying strata as those of northern Southampton, with similar capacities and adaptations. At Newtown, and its vicinity, the brown shale largely prevails, with deep, loamy, some gravely, and small areas of clayey soils, with fairly large water and splendid fertility holding capacity, adapted for raising the regular farm crops; but especially wheat and timothy hay, of which these soils will produce large yield of superior quality. Among the long season legumes, alsike and in the more gravely soils, alfalfa and the red clover, will produce inviting crops, and whenever the Canada field pea can be sown sufficiently early it produces

large crops of a splendid roughage, as well as grain when allowed to ripen. Silage corn produces as large yields throughout this section as anywhere in the State, but usually not as large yields as in the Syenitic and Micaceous soils in the southern part of the county. Soils of the same derivation occur from Newtown eastward to the Delaware River, or rather to the alluvial deposits discussed under Lower Wakefield township. Throughout this entire section are considerable areas of low and spouty soils, needing underdraining and unless underdrained, not adapted for raising the crops above referred to. About all of this land needs lime, which could be supplied in the form of the finely ground carbonate or limestone, except on the low, spouty clayed soils, where a heavy application of caustic lime will almost work miracles in the way of increased production and the improvement of the physical condition of the soil.

The following townships, south of the Potsdam and limestone outcrop in Doylestown, Buckingham and Solebury townships, have soils derived from similar strata of Mesozoic Age: Warminster, Warwick, Wrightstown and Upper Wakefield.

WARMINSTER TOWNSHIP

This township lies north of Southampton, on the Montgomery county line. The land is moderately and gently rolling with, where the gravels and shales prevail, deep comparatively warm, loamy soils, with fair water and fertility holding capacity, adapted for raising the same crops as those of the township previously discussed; while where the soils are derived from the easily disintegrated shales, they are clayey, and readily become water-logged, and are cold and cannot be farmed sufficiently early to start early summer ripening, spring seeded crops, such as the Canada field pea and oats, unless the land is thoroughly underdrained, and the soil contains a large quantity of organic matter derived from plowing down heavy sod, and from manures.

WARWICK TOWNSHIP

This township lies east of Warminster and north of Northampton townships. The land is gently rolling. The soils are derived from the brown, gray, blue and red shales, and sandstones of the Mesozoic Age, with soils that are deep with large fertility and water holding capacity in harmony with the readiness with which these strata yield to the agencies of disintegration, and are in all respects similar to the soils of Warminster except that along Neshiminy Creek, the land is more fertile, and will produce larger forage crops than on the higher elevations.

WRIGHTSTOWN TOWNSHIP

This township lies east of Warwick and north of Northampton. The soils are derived from the same strata as those of the township previously discussed. At Wycombe, in the western part of the township, the soils are derived from the brown shales, and are deep for this formation, with large fertility and fairly large water holding capacity, adapted for raising all the regular farm crops, with special adaptation on the loamy soils for raising wheat and the clayey soils for raising timothy hay. At Wrightstown, along the eastern boundary, the soils are derived from the same rocky strata, with similar capacities and adaptations as those of townships previously discussed.

UPPER WAKEFIELD TOWNSHIP

This township lies east of Wrightstown, north of Lower Wakefield along the Delaware River. The soils of the township are derived from the Mesozoic gray and red shales, the trap rock, and the alluvium along the river. The trap exposures occur along the northern border of the township. The soils are deep, loamy gravels, with large water and fertility holding capacity the more stony types, adapted for raising peaches, of which they will produce strong, vigorous, disease resisting trees that will yield large crops of well developed, nicely colored and flavored fruit; while the more loamy soils are splendidly adapted for raising the regular farm crops, but specially adapted for raising hard, red wheat and a good quality of corn, and when lime is applied the legumes, among them the alfalfa, and the Canada field peas and oats, as well as the soja beans. The alluvial soils along the river are well adapted for raising early truck crops, and wherever possible, these soils should be used for this purpose.

The soils of Mesozoic origin have, in many sections, been changed by the intrusive trap rock, are deep and the gravelly types warm, with fairly large water and fertility holding capacity. With the markets ready to consume all that these soils will produce and more than all they will produce, such a rotation of both soil improving and soil exhausting crops should be arranged as will take advantage of the entire growing season, and at the same time produce the largest amount of human nutrition and keep up and increase the productive capacity of these soils. The soils derived from the Mesozoic rock have a great capacity to consume organic matter, and obtain from an application of straw as much or more permanent benefit than from the application of a fair grade of commercial fertilizer. It can be truthfully said of these soils, supply the organic matter and they will produce the crops. Therefore, with such evident crops and the large number of crops, both the soil improving

and soil exhausting, that can be grown under prevailing climatic and soil conditions it is only necessary to work out a system of cropping that embraces both propositions, namely the raising of crops for human nutrition, and for maintaining and increasing the fertility of the soil.

Doylestown, Buckingham and Solebury townships have soils derived from the same geological formations, namely the Mesozoic, the Silurio Cambrian limestone, the Potsdam sandstone and the trap rock.

DOYLESTOWN TOWNSHIP

This township lies north of Warrington and northwest of Warwick. The limestone comes to the surface east of Doylestown and enters into the composition of the soil. It is the only limestone outcrop of any size through the entire county, except that in the valley of Durham Creek, near the northern border, and it should be used as the source of lime for the soils derived from the Mesozoic strata and the trap rock, many of which are naturally deficient in this element. In all probability this limestone finely ground would supply this deficiency though more slowly, but equally as efficiently as the burned lime with the exceptions previously indicated, the clayey, spouty soils of trap and Mesozoic derivation.

The comparatively narrow sections of Potsdam sandstone and limestone outcrop, beginning in this township, make a more hilly, though moderately rolling section, with deep, warm, early spring farming soils, with large water and fertility holding capacity adapted for raising early truck crops as well as for raising fall sown, early summer ripening crops, and for seeding early spring, summer ripening crops. These are among the large crop accommodating soils in this county, and will produce large yields of corn and wheat of superior quality, as well as large yields of the legumes among the long season, alfalfa, red and alsike clovers, and among the short season, the Canada field pea, the winter vetch, the soy or soja beans and northern grown cowpeas. The soils derived from the Mesozoic strata, following this Potsdam sandstone and limestone outcrop, are deeper, more limy, with large water and fertility holding capacity, than the soils of Mesozoic origin in other parts of the county are, and will produce equally as large crops of the cereals, corn, oats and wheat as the limestone soils will, and equal to and likely superior in quality. The legumes, previously enumerated, find as congenial a soil environment here as in the limestone soils and more congenial than the soils in which the Potsdam sandstone prevails. The soils derived from the Mesozoic strata beyond the limits of the more limy and deeper soils, are similar to those previously discussed.

BUCKINGHAM TOWNSHIP

This township lies east of Doylestown and north of Wrightstown townships. The soils of this township are derived from the same geological formations as those of Doylestown and have similar adaptations and capacities, and therefore need no further discussion at this place.

SOLEBURY TOWNSHIP

This township lies east of Buckingham and north of Upper Wakefield, along the Delaware River. The soils of this township are derived from the same geological formations as those of Buckingham, except that the Potsdam sandstone is limited and seems to disappear before reaching the Delaware River, and that at Newhope, in the south central part of the township, a mass of trap appears and makes a section of soils similar to those in the northern part of upper Wakefield township, with similar capacities and adaptations; and that along the river the alluvial soils, discussed in Upper Wakefield township, occur, which also have similar capacities and adaptations as those discussed in that township.

The following townships lying north of the limestone upheaval of the township, and parts of townships previously discussed, have soils derived largely from the red shale and sandstone of Mesozoic Age: Warrington, New Britain, Hilltown, East and West Rockhill, Plumstead, Bedminster, Tinicum, Rockamixon and southern Haycock.

WARRINGTON TOWNSHIP

This township lies north of Warminster, on the Montgomery county line. The soils of the township are considerably benefited by the limestone upheaval, referred to in Doylestown township. The limestone does not appear on the surface, but evidently the lower strata of the Mesozoic are brought up, and whether these are more limy or contain other elements that make soils productive, or whether the breaking of the strata had a beneficial effect, or whether all these have worked together to enhance the productiveness of the soil, whatever it may be, the fact that the soils are more productive is evident. The gray and brown shales largely prevail in the formation of the soils of this township, and are beside the upheaval above referred to similar to the soils of the township farther south.

NEW BRITAIN AND HILLTOWN TOWNSHIPS

The former lies north of Warrington, and the latter north of the former, with the Montgomery county line forming the western boundary of both. The soils of these two townships are derived largely from the red shale and sandstone of Mesozoic Age. This entire section is moderately, and much of it gently rolling, with numerous

small sections that are flat. Along the streams, in many places, the banks slope steeply, some even precipitously while wherever the streams curve in their courses, the land is gently rolling, the soils fertile and adapted to even intensive farming. Wherever the precipitous slopes occur, the underlying rock is harder and more resistant to the agencies of disintegration, and the soil washed away as fast as it is made, and therefore the land is stony, or the bare rock remains on the surface, producing sections too stony and rocky for raising agricultural crops. The same conditions exist on some of the rolling land away from the streams underlaid with rock of similar resisting capacity to the agencies of disintegration, and the consequent formation of them, thin and sometimes stony soils with so limited a water holding capacity that with only a slight abnormalty of rainfall in the spring, these soils become water-logged and remain cold so long, that winter crops such as rye, wheat and the hay grasses cannot begin sufficiently early to produce a full crop before the ripening season. And spring farming operations are delayed, so that spring crops cannot be started sufficiently early to escape only a nominally dry season in July when these soils, because of their limited water holding capacity, are so dry during only a normally dry season, as they are wet in the spring, showing that crop yields are, because of the imperviousness to water and the resistance to disintegrating agencies of the underlying strata curtailed very much by too much and not enough rainfall. Underdraining will, in part, mitigate the effects of too much rainfall, but will be of little or no benefit when there is not enough, except that when the drains are sufficiently large, they will furnish a supply of air for the soil which is very essential.

With an adequate supply of organic matter, which is necessary to hold the excess of water during a wet season in capillary condition, making the soils apparently dryer and warmer in the spring so that winter crops can make an early start and ripen a full crop, and for farming operations to begin sufficiently early to take advantage of the entire growing season and also for keeping the soils moister and cooler during the hot summer and in this way provide a congenial soil environment for plants to grow during abnormal and normal seasons, much larger returns can be realized from these soils. With such a demonstration of the effects of organic matter in the soils and with the possibility of producing it by raising crops that will yield or can be converted into as large an amount of human nutrition, makes the proposition a very inviting one. These soils will not much longer produce the three soil exhausting crops, corn, oats and wheat in succession without the interposition of soil improving crops, all of which can be done by raising such crops as

crimson clover, winter vetch with rye, the northern grown cowpea the soja bean and the Canada field pea, an array of crops for the raising of which these soils can be adapted if they are not now so adapted. These soils vary in depth from six inches on the hilly formations referred to, to a number of feet on the gently rolling, but usually the underlying red shale at this depth is impervious to water and these soils become saturated and are cold and wet, and require a treatment in harmony with that above suggested. The red shale and sandstone soils prevail throughout the northern and western parts of New Britain, and while at New Britain, and from there eastward and at Chalfont, and there southward, are some of the low, wet, cold soils which need underdrainage and a supply of organic matter that will put the soils into the condition above discussed. At Sellersville, Perkasie and throughout West and East Rockhill townships the red shales prevail with soils similar to those previously discusssed requiring similar treatment.

PLUMSTEAD TOWNSHIP

This township lies east of Hilltown and New Britain along the Delaware River, with soils of similar derivation, capacity and adaptations, except along the river, as those of the two previously discussed townships, requiring similar treatment. Rye yields splendid crops on these soils at this time, and should be made one of the money crops.

BEDMINSTER TOWNSHIP

Bedminster township lies east of Rockhill and Hilltown and north of Plumstead, with soils similar in derivation, capacity and adaptations as those of Plumstead township.

TINICUM TOWNSHIP

This township lies east of Bedminster and north of Plumstead, along the Delaware River. The township has some of the brown and grey soils derived from rock such as were discussed in Warrington township to which the reader is referred.

NOCKAMIXON TOWNSHIP

This township lies north of Tinicum along the curve of the Delaware River. The soils through the central part are derived from the gray Mesozoic sandstone and shales, with similar soils, having similar capacities and adaptations, while along the northern border of the township the Syenitic rock combines with these strata in the formation of the soil, making soils similar in derivation as those extending along the Syenitic escarpment, discussed in the southern townships, except that land is more hilly and stony, and not so well

adapted for farming, but equally well adapted for fruit raising and forestry. In the southern part of the township the soils are derived from the red shales and sandstones and are similar to townships previously discussed.

HAYCOCK TOWNSHIP

This township lies west of Nockamixon and north of Bedminster. The soils of this township are derived from the red and gray shales and sandstones and the trap rock prevailing at Haycock Mountain. The soils at the base of this mountain, and for considerable distances away from it, are derived from a mixture of the trap and Mesozoic, gray shales and are fertile, the more loamy and gravelly types adapted to raise the regular farm crops, but especially adapted for raising wheat of which they will produce large yields of a hard, red, high milling quality. The more stony and rocky types will produce peaches and apples, otherwise the soils of this township are similar to those of Nockamixon.

Richland, Milford and northern Rockhill townships have soils derived from similar rock structures.

MILFORD TOWNSHIP

Milford township occupies the northwestern corner of this county, with the Lehigh county line for its northern and the Montgomery county line for its western boundary. A trap dyke, coming in from Montgomery county, and referred to in the discussion of that county under upper Pottsgrove township, extends along the northern border of Rockhill and the southern border of Milford townships, with soils similar to those discussed under Haycock township. This same formation occurs in the northwestern corner of Milford township, as well as in several places along the northern border. The soils derived from these formations are rocky, stony, gravelly, loamy and clayey. The trap rock being harder than that of the surrounding formation, makes ridges on these the rocky and stony land occurs with frequent gravelly and loamy sections, while the clayey soils occur where formations have mixed or been broken up. Where the land is so stony that agricultural operations are impossible, there fruit trees seem to grow more vigorously than elsewhere, an indication of what these soils will do. Throughout the remaining sections of this township the gray shales largely prevail with soils such as have been previously discussed.

RICHLAND TOWNSHIP

This township lies east of Milford and north of Rockhill. The soils of this township are derived from the same strata and rock exposures as those of Milford and Rockhill. At Quakertown and in

its vicinity, is an illustrative section where soils are derived from the intrusive trap and the Mesozoic rock, and are fertile, with large water and fertility holding capacity, adapted for raising all the regular farm crops, but especially adapted for raising wheat and corn, of which they will produce fairly large yields of splendid quality. These soils when lime is applied will also produce the legumes, among the long season alfalfa, red and alsike clover, and among the short season, the crimson clover, the winter vetch, the Canada field pea, and the northern grown cowpea and soja beans. At Richlandtown and between it and Quakertown is one of the low, wet, clayey sections of soils of this formation, which needs underdraining and which when underdrained can, with the application of some lime and organic matter, be made as productive land as any throughout this section. On the higher elevations the land is rocky and stony adapted for fruit raising, an industry that has been sufficiently developed in this section to demonstrate its possibilities. The sandstone also occurs north of these formations with thin soils requiring the treatment given in connection with the discussion of Hilltown, Britain and Rockhill townships. Springfield and Durham townships have soils derived from the same rock exposures.

SPRINGFIELD TOWNSHIP

This township lies north of Haycock and Richland, and east of Milford, with the Lehigh county line for its northern boundary. The soils of the township are derived from the Mesozoic shale and sandstone, the Silurio Cambrian limestone, the Potsdam sandstone, and the Syenitic and Gneissic exposures. The land is hilly, and wherever the Potsdam sandstone prevails, rocky and stony, and not adapted for raising farm crops or for farming, but for growing forests and fruit, the more rocky and stony for forest and the stony and gravelly for friut. Where the Mesozoic, the Gnessic, Syenitic and the Potsdam enter into the formation of the soils, which is the case for more than half the distance along the line of contact of these various formations, in this township, there the apple soils occur which without any visible benefit derived from commercial fertilizer, will produce vigorous, disease resisting trees, which will yield large crops of well developed, highly colored, nicely flavored fruit. Some Gneissic, Syenitic and Mesozoic soils also occur throughout these lines of contact in this township, which will produce strong, vigorous, disease resisting peach trees, which will, without any visible benefit from artificial fertilization yield large crops of well developed, highly colored, nicely flavored fruit. In the valley of Durham Creek the limestone enters into the formation of the soils, and it, together with the Potsdam, which accompanies it on both sides of the valley,

make on the higher elevations, rocky, and the lower slopes, deep, warm, early spring farming, stony and gravelly loams and loamy soils with fairly large water and fertility holding capacity, adapted for raising all the regular agricultural crops, but especially adapted for raising wheat, the legumes and potatoes. A rotation of clover, potato and wheat should yield inviting returns, and with the application of manure in the clover sod and such elements of a commercial fertilizer as may be necessary, the fertility of this land should be maintained. North of this valley, and along the Lehigh county line, the Gneissic and Potsdam sandstone rock makes deep, stony, loamy, gravelly loams and loams with fairly large water and fertility holding capacity, adapted for raising the regular farm crops, but especially for raising wheat, the clovers and potatoes, and also for raising fruit.

DURHAM TOWNSHIP

This township occupies the northeastern corner of Bucks county, with the Delaware River for its eastern and the Lehigh county line for its northern boundary. The soils of this township are derived from the same geological formations as those of Springfield, with similar capacities and adaptations. The limestone valley widens as it approaches the river, and exposes the rock, so that it can be easily quarried and burned into lime, or the stone finely ground and prepared to be applied on the various types of soils throughout this county, about all of which are either naturally deficient in lime or need it to make them active and to neutralize acidity.

NORTHAMPTON COUNTY

Northampton county was erected during the joint proprietorship of Thomas Penn and Richard Penn, in the spring of 1752. It contains 238,080 acres, of which 192,851 acres is land in farms, and of which 165,618 acres is improved farm land. 25,148 acres were planted with corn in 1909, yielding 884,987 bushels; 21,003 acres were sown with oats, yielding 549,810 bushels; 26,441 acres were sown with wheat, yielding 511,223 bushels; 1,228 acres were sown with buckwheat, yielding 21,667 bushels; 16,810 acres were sown with rye, yielding 249,147 bushels; 5,264 acres were planted with potatoes, yielding 481,128 bushels; 32,765 acres were sown with all forage crops, yielding 42,169 tons of the various kinds of hay. Of the 165,618 acres of improved farm land, 128,659 were used for raising farm crops, while 36,959 acres were not so used and more likely

producing weeds. At this time Northampton had a population of 127,667 to feed, 19,442 cattle, 8,634 horses, 113 mules, 18,463 swine and 1,610 sheep.

The county lies south of Monroe and Carbon, east of Lehigh, north of Lehigh and Bucks, with the Delaware River for its eastern boundary. The underlying strata, from the disintegration of which the soils of this county are formed, begin with the Gneiss, the Potsdam sandstone in the southern part of the county, the Silurio Cambrian limestone through the central part and the Utica and Hudson River slates in the northern part, with small sections of Medina sandstone along the Blue or Kittatinny Mountain.

The county divides itself into three great soil belts extending north, east and southwest. The southern, the Gneissic or Syenite belt, about five miles wide, the second, the middle or limestone belt, about seven miles wide, and the third, or northern slate belt, seven miles wide, including the small areas of Medina sandstone soils.

The drainage of the eastern part of the county is accomplished by the Delaware River and its tributaries, such as Richmond Creek which flows into it near Belvidere; Martin's Creek, which enters the river about six miles from this place; Bushkill Creek, which enters into the river at Easton.

The remaining parts of the county are drained by the Lehigh River and its branches. Monocacy rises in the North Mountain, flows through the slate and limestone belts into the Lehigh at Bethlehem. The Catasauqua rises in the slate belt and flows south into the Lehigh about three miles above Allentown, while the Hokendauqua Creek flows in a similar direction and empties into the Lehigh about three miles above the Catasauqua. Saucon and Fry's Creek drain the township south of the Lehigh into the Delaware.

WILLIAMS AND LOWER SAUCON TOWNSHIPS

Williams township occupies the southeastern corner of the county, with the Lehigh River for its northern boundary and the Delaware for its eastern and the Bucks county line for its southern boundary. The Pohatiunk Mountain range of New Jersey makes a ridge along the southern border of the township, the Baugher Hills, with two summits overlook the gap made by the river.

The land here is rough and stony and some of it difficult to farm. The soil on the hills and the hillsides is made of the underlying Gneiss strata while, where the limestone and the Gneiss combine on the lower slopes, though the soils are still rough and stony in some places they are fertile making among the best grain, especially wheat and corn soils that exist anywhere. These also are among the best potato soils in this section, having sufficient gravel and sand to keep

the soil open and enough potash and lime to produce innumerable crops of grain as well as potatoes. The limestone valley north of this ridge has a gravelly soil, though more limy than the soil closer to the hills.

This limestone valley narrows until at Stout's and further westward the limestone entirely disappears as well as the Southern Mountain, and only between Uhlersville and Raubville, along the river a low ridge comes up to the river, having the same soil formation already discussed. About two miles south of Easton the Delaware River cuts through Morgan's Hill and changes its course westward and flows along the foot of a very steep slope of the hill. This ridge extends southward through this and part of **Lower Saucon** township to Shimersville. Here the Lehigh River flows directly against the mountain and changes its course northward around it, and again eastward along its base with little or no farming land on the southside of its banks in this part of its course. Further northeastward the distance between the river and the mountain increases until south of Easton it approximates two miles, forming a valley of wonderful intensive agricultural possibilities. This valley has direct connection with all the eastern markets and has among the best local markets for all kinds of agricultural and horticultural products. Along the north and south sides and upon the crest of Morgan's Hill, are many small, and some quite extensive sections of the best apple, peach and small fruit soils in this part of the State.

LOWER SAUCON TOWNSHIP

The Southern or Pohatiunk Mountain broadens in this township and covers the whole of the southeastern section as far north as the east branch of Saucon Creek and westward to Leithsville in the southern angle of the township where it terminates in a series of Potsdam sandstone noses along the Saucon Valley limestone formation and thence northward to the valley already indicated the Little Saucon Creek. The Saucon Valley begins at Shimersville, where the Saucon Creek flows into the Lehigh River and extends southwestward through Lower Saucon, in Northampton county, and through Upper Saucon in Lehigh.

This valley along the line of contact between the Potsdam sandstone and the limestone, has some hilly and stony land some of it diffcult to farm but very productive.

The cereal grains, potatoes and the clovers thrive splendidly here. Apple trees growing in these soils have a thriftiness not surpassed anywhere in the State. The central part of the valley is underlaid with the Silurio Cambrian limestone and, as usual, the soil is fertile and will produce larger crops successively than any soil in the

State. The northeastern extremity of the South Mountain occupies the northwestern corner of this township south of South Bethlehem. The soils along the sides of the mountain and the crest are similar to those already discussed namely, the gravelly, sandy, loamy and sometimes clayey soils of the Gneiss and limestone strata. These two townships are the apple, peach, small fruit, berry and market gardening section of the county. Early vegetables can be produced in these soils.

The limestone plain of Northampton county extends from the Lehigh River along the western border for a distance of thirteen miles, including Hanover township, Lehigh county, to the Delaware on the eastern boundary with a width of seven miles from north to south.

The following townships and parts of townships are embraced in this valley: Southern Allen, southern East Allen, Hanover, Bethlehem, Lower Nazareth, southern Upper Nazareth, Palmer, Forks and the southern part of Lower Mount Bethel.

Three types of limestone or limy strata occur throughout this district, the pure limestone containing as much as 95% of the carbonate of lime; the magnesia containing as high as 40% Carbonate of Magnesia, together with from 30% to 50% and more per cent. of Carbonate of Lime; and the Hydraulic limestone containing as high as 15.86% of Silicia and 16.85% per cent. Aluminum and Ferric Oxide, which show one-third of the stone to be composed of sand and the poorest kind of mud. These three types of stone are the basis of the soils of this district, and each one has its individual effects on the producing capacity and the crop adaptability of the soils. Another though less extensive, the limy Gneiss and sandy or cherty strata entering the formation of the soil occurs along Morgan's Hill, already referred to, where a course sandstone gradually changes into a sandy limestone making, what might be rightly termed, a sandy limestone soil, especially where the agencies of disintegration have not completely removed the limestone which is the case here, because the disintegrated material still contained Carbonate of Lime. Along this same hill limestone strata outcrop which enter the formation of the soil which contain the Micaceous formation of the Gneiss strata which form Morgan Hill and a combination of limestone and Micaceous materials enter the soil and, in many cases, produce good effects, making the potato and cereal grain and apple soils of this mountain. This same formation occurs in Chestnut Hill, in Palmer and Forks townships just north of Easton. Along the northern side of this ridge the limestone and the Gneiss form what are termed Chazy limestone strata from which the soils is partly derived with similar adaptabilities to those already referred to. Quaker and Pine

Hills, in Bethlehem and Hanover townships, are a continuation southwestward of Chestnut Ridge, with formations similar to those of Chestnut Hill, except that at the southern base of Chestnut Ridge an outcrop of Serpentine occurs with a soil of little agricultural value, while in Quaker and Pine Ridge the Serpentine does not occur. North of the Lehigh River to the base of the Utica and Hudson River slates, the limestone strata make the basis of the soil throughout the whole length of the townships and forms one among the many fertile sections of the State. The limestone on which Bethlehem is located, gives a splendid impression of the character of the land throughout the county.

Moderately rolling as the general section of the county appears, if the underlying strata had been hard and not readily acted upon by the agencies of disintegration, this would be one of the most hilly and gnarled sections of the State, because the underlying strata are twisted and thrown out of all relations to their former position. But being readily acted upon by the agencies of disintegration, especially the chemical agencies, the land is rolling. Whether these agencies act more readily on the Carbonate of Lime than on the Carbonate of Magnesia, the author does not know, but that a soil formed entirely from the disintegrated magnesia strata differs in its adaptations from one formed from purely disintegrated limestone strata is evident, because in a number of strips throughout this valley, for no evident reason, cereal grains especially, do not yield well, clovers can not be made to hold unless lime is applied, and yet the soil is rich in magnesia but low in lime, and should not be acid.

Further northward in this limestone belt this does not seem to be as evident, and yet these magnesia strata are distributed, promiscuously, throughout this limestone formation. Another thing, like other rock strata these differ in hardness. The dark blue limestone strata are usually the hardest and are not so easily acted on by the agencies of disintegration and therefore make ridges and not as deep a soil as the more easily acted on strata do. The softer strata or formations make the valleys and nicely rolling landscape.

Frequently sink holes occur in these valleys showing that the easily disintegrated formations extend to great depth. Sometimes the very valleys in which the sink holes occur were at one time sink holes which now have lost their roofs and underneath a second roof the same old process is being repeated, and consequently dry valleys with underground streams occur throughout this limestone section. The limestone outcroppings throughout the fields in this county are the remanents of the strata less readily acted on by the atmospheric agencies of disintegration and make a soil so rocky that it is difficult to farm, but always productive.

Another limestone in which the magnesium has largely decreased and in which the alumina has increased underlies a considerable acreage of the soils, in the vicinity of Copley, at Siegfried, along the east and west banks of the Lehigh River, along Hokendauqua Creek and in many other places throughout this section. This is the hydraulic limestone, or the cement stone, the soils formed by the disintegration of which are loams, clays and shaly gravels and are adapted to raising the regular farm crops, in some places producing even larger crops than the Magnesia or Trenton or limy limestone.

The following analyses give the approximate average composition of the magnesia, the calciferous or limy limestone and the cement or the hydraulic limestone.

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	2nd Pa. Geo. Survey D.D. Page 18, No. 1.	Page 17, No. 2.		
Carbonate of lime,	59.690	86.260		84.05
Carbonate of magnesia,	32.690	00.400		0.17
Oxide of iron and alumina,	1.666	4.500		0.09
Phosphorus,	0.011	0.014	Insoluble silicate,	15.07
Silica,	5.590	8.160	Water,	2.42

These analysis give an approximate idea of the composition of the Magnesia, the limy and the hydraulic limestone throughout this county and give some notion of the soils formed therefrom.

Bordering the limestone formation, an almost sudden change takes place in the underlying strata. The slate or thin slaty limestone strata take the place of the limestone, the country becomes more hilly, and in many places, rises abruptly from the limestone plain into the Utica shale or slate formation which underlies the Hudson River slates. Where these softer strata of dark, sometimes black strata of limy Utica shales remain the land is fertile and as productive, or even more productive, than the limestone soils beside it. This soil usually contains a larger amount of potash than the limestone clay and in the average farming operation it seems should not require the application of this element for the successful production of crops.

This, as already indicated, is the third or slate belt of soils, extending northwestward through the county, with a width of about seven miles, containing the following townships, beginning with the Lehigh River: Northern Allen, Lehigh, Moore, Bushkill, Plainfield, Washington, Lower Mount Bethel and Upper Mount Bethel.

UPPER MOUNT BETHEL TOWNSHIP

Upper Mount Bethel occupies the northeastern corner of the county, with the Delaware for its eastern border and Monroe county for its northern. Along the Delaware, in the southern part of the township, between the curve at Belvidere and the southeastern corner of the township, is a rolling section of country of more fertile soil

than the Hudson River slates usually form, adapted, a considerable acreage, to market gardening and small fruit as well as for raising apples and peaches. Further northward along the river are similar but smaller sections with the same soil formation but not as fertile. Northward through the central part of the township the land is hilly until the limestone outcrop, which extends nearly through the entire length of the township and along the Delaware River at Portland, having a width of over a mile, is reached. Here the land becomes more rolling, especially along the river and is fertile, adapted especially for raising wheat, potatoes and clovers. Portland is built in the Terminal Moraine.

Fruit, especially apples, thrive here. Wood growth is luxuriant. In a number of places the forest and undergrowth is so intense that growth seems not to be a question of fertility but one of sunlight. Westward along the limestone crop, the limestone, the Utica shale, and glacial drift make the soil. The soil is fertile and endures abuse for a long time, and still yields fair returns. The northern part of this township is rough, hilly and even mountainous, with little farming land, except where the morainic materials form swamps and rolling land, as in the north corner of the township.

LOWER MOUNT PLEASANT TOWNSHIP

This township lies west of Upper Mount Bethel, with the Delaware River for its southern boundary. The southeastern part of the township along the river is in the limestone formation, and these, together with the softer shales and drift materials, form the soil which is well adapted to trucking and market gardening. It has been reported that a very delicately flavored melon has been raised here for a long time.

From the central part of this township northward, the soil is formed of the underlying strata of Utica and Hudson River slates. At Mt. Pleasant and thence northward is a rolling section with fairly fertile soil, adapted to raising potatoes, wheat, and with lime, the clovers. This township is not as hilly as the townships further north. White oak, hickory and chestnut timber thrive in this vicinity.

WASHINGTON TOWNSHIP

This township lies north of Lower Mt. Pleasant and west of Upper Mt. Pleasant. The southern part of the township is a continuation of soil conditions as they exist in Lower Mt. Pleasant township. In the south central part of the township, west of Flicksville, is a rolling upland section formed of a more readily disintegrated slate, and consequently a more rolling landscape is formed, more easily farmed and more productive. Northward from Ackermansville to

Bangor, the land is stony and much of it hilly, with some uplands that produce fairly well, but a large acreage of this land should be reforested or maintained in forest. The effects of glacial action is manifest throughout this section in the formation and the fertility of the soil and in the formation of sections of spongy soils and land too wet for farming which should be underdrained. Apple trees look thrifty throughout this section. From Bangor, on Martin's Creek, to Penargyl is some farming land, but the Medina sandstone and the Oneida conglomerate come down from the mountain and in many places make rough and stony soil.

South of Penargyl, in Plainfield township, where the mountain sandstone do not enter the formation of the soil, is some rolling, easily farmed and fairly productive land which continues southwestward to Wind Gap. From Wind Gap southward the rolling land continues and becomes more moderately rolling as the limestone valley is approached, which touches the southern border of this township. In Plainfield township the roofing slate formation occurs at Penargyl in the northern part and thence southwestward, and at Belfast, in the south central part, and thence northward and southward with the accompanying softer slates and clay soils.

BUSHKILL TOWNSHIP

Bushkill township lies west of Plainfield, above referred to, and, like Plainfield, extends from the Kittatinny Mountain crest to the limestone valley at Nazareth. The slate formation rises from the limestone plain immediately north of Nazareth, and forms soils similar in character to those of Plainfield, some stony, gravely, loamy and others clayey. The soils of these townships are derived, south of the mountain, and south of the slope of the mountain along which the debris of the mountain covers the surface with talus, the more sandy and stony likely, of the upper part of the slate or Hudson River series. The clayey soils are formed of the soft shaly strata, while in the roofing slate belt, which represents about 1,500 feet of the 5,240 feet wherever these underlie the soil, the clays prevail because of the fineness of the particles or mud of which the strata is composed.

This slate formation in this series of strata is not confined to a strip of territory extending northeast and southwest along the mountain or along the limestone formation, but on account of the faults and the folding or curving of the strata, outcrops occur within a mile of North Mountain, while others are five miles from the mountain and only two miles from the limestone belt south of the slate. So that this belt may vary within one to three miles throughout which these strata in many sections form the basis of the soil. The softer

and therefore the readily disintegrated slates are usually beneath the roofing slate section and therefore the more rolling and frequently gently rolling soils are found in the southern section of this formation along the limestone belt.

MOORE TOWNSHIP

This township lies west of Bushkill and extends from the Kittatinny Mountain nearly to the limestone belt. The roofing slate formation ranges through the south central part of the township with the more extensive outcrops near Chapman's north, east, south and west of this place. South of this belt the softer strata form the basis of the soil, while northward the sandy strata already referred to make a hilly and stony country, much of which should be in forest or should be reforested.

NORTHERN ALLEN AND NORTHERN EAST ALLEN TOWNSHIPS

In the northern part of both these townships, the Trenton limestone, the hydraulic limestone, the Damourite slate, the lower softer slate belt, the roofing slate and likely, some of the sandy strata, occur. In these townships the contact between Slate Hills and the limestone valley is very nicely shown, as well as in the outcropping patches of limestone at Bath an about a mile east of Salem and east of Kreidelersville.

These patches of limestone are brought up by an upward curve of the strata which passes through this part of these townships and makes soils composed of all the strata that enter the formation, among which are the Damourite strata, how much they amount to is difficult to determine, but that they have an important influence on the physical condition of the soil is evident from the fact that in connection with the black or dark slates of the lower or Utica formation they form dark colored soils, which are warmer, not so readily affected, either by dry or wet seasons, and are more productive than the lighter colored and sandy formations. The effects of the limestone, both the hydraulic and the Trenton and the magnesia has already been referred to as gravely and clayey soils of splendid fertility. It is evident from the strata that enter the soils in this northern section of these townships, that it is among the most fertile of the Hudson River and Utica slate formations in the State.

LEHIGH TOWNSHIP

Lehigh township occupies the northwestern corner of this county. The southern part of the township contains the softer shales and therefore the more rolling land and the more desirable soil. In the curve of the river at Triechlerville is a beautiful alluvial deposit of fertile

soil. Throughout the central part of the township the land is rolling with soils the more loamy, splendidly adapted to raising potatoes and the cereal grains.

Throughout the northern central part of the township the roofing slate belt prevails with numerous opening of slate quarries. The soil wherever formed from the disintegrated strata of these slates, is clayey, and where the strata are not easily acted on by the agencies of disintegration the soils are stony and in some places so hilly that farming is made difficult, while in other sections the land is gently rolling. From Walnutport eastward and as far north as Danielsville and all along the L. & N. C. R. R., the roofing slate formation prevails which some of the more readily disintegrated underlying strata, forming fertile soils. This is one of the richest of the smaller agricultural counties of the State. It has a large variety of formations, with soils especially adapted to a wide range of agricultural and horticultural activities. The soils of the Gneissic and Potsdam formations, especially adapted for apple and peach growing or all the stone fruits that thrive in this climate, will grow in these soils.

These soils will also produce a high grade of red wheat of superior milling quality, as well as a high grade of potatoes. The intermingling of the Potsdam and the limestone, with probably some Gneiss, makes soils adapted for the raising of similar crops. The limestone valleys and the alluvial soils along the streams are among *the fertile soils of the State,* adapted to the raising of all agricultural crops that thrive in this climate.

Every two acres of improved farming land in the limestone and the alluvial soils, with right method will produce sufficient crops to feed one cow for one year. There are likely between eighty and ninety thousand acres of these soils in this county. Much of the northern section is well adapted to fruit raising, as well as potatoes and the cereal grains.

FULTON COUNTY

Fulton county was erected out of a part of Bedford county and organized under Act of Assembly April 19, 1850. It contains 257,280 acres, of which 196,858 acres is land in farms, and of which 107,037 acres is improved farm land. Fourteen thousand and seven acres were planted in corn in 1909, yielding 300,849 bushels; 3,107 acres were sown in oats, yielding 61,441 bushels; 13,869 acres were sown with wheat, yielding 188,323 bushels; 3,767 acres were sown with buckwheat, yielding 45,451 bushels; 3,917 acres were sown with rye,

yielding 36,218 bushels; 793 acres were planted with potatoes, yielding 74,197 bushels, and 14,118 acres were sown with all forage crops, yielding 14,792 tons of the various kinds of hay. Of the 107,037 acres of improved farm land, 53,578 were used for raising farm crops, while 53,461 were not so used and were likely producing weeds. At this time the county had a population of 9,703 to feed, 8,809 cattle, 3,611 horses, 203 mules, 6,102 swine and 8, 353 sheep.

Fulton county lies south of Huntingdon, west of Franklin, east of Bedford on the Maryland line. The strata which form the basis of the soils of the county range from the coal measures in the northwestern corner, on Broad Top Mountain, down through a small outcrop of Pottsville conglomerate, through the Mauch Chunk red shale, the Pocono sandstone, the Catskill red sandstone, the Chemung shales, the Portage flags, the Hamilton shales, the Oriskany sandstone, the Lower Helderberg limestone, the Clinton shale, and Fossil iron ore, the Medina and Oneida sandstone, the Hudson River slates and the Trenton Chazy calciferous limestone No. 2 in the McConnellsburg Valley.

The drainage of the county belongs to two systems, that of the Potomac and the Susquehanna Rivers. The latter extends only into Wells, Taylor, Dublin and Brush Creek through its branches. Brush Creek drains Brush Creek township and Sideling Hill, and Ten Mile Run drains the northern part of Wells, Taylor and Dublin townships. The central and southern townships are drained into the Potomac by Licking Creek, Tonoloway Creek and smaller streams, such as Big Cove Creek which flows into Licking Creek from McConnellsburg Cove.

UNION TOWNSHIP

Union township occupies the southwestern corner of Fulton county, along the Maryland line. The rock strata from which the soils of this township are formed, begin with the Pocono on Town Hill, which forms the western boundary between this and Bedford county, and Sideling Hill which forms the eastern boundary line, between this and Bethel township and ranges down into the Catskill immediately beneath the Pocono. Sideling Hill Creek flows across the southwestern corner of the township. It makes a rather wide rolling gap through Town Hill in which all the Pocono has been carried away and in which are some nicely rolling soils on the Catskill, especially some distance east of this gap. From here southward, as well as northward, the soft Catskill strata with which the whole township is underlaid, have yielded to disintegration and the land is moderately rolling, with well rounded hillsides, easily farmed and productive. Farther northward the land becomes more steeply hilly along the streams, but the uplands are still rolling and easily farmed. These

Catskill soils are very similar to the Catskill soils of Wyoming, Lackawanna and other northeastern counties which, in the discussion of these counties, were called nature's apple soils. A considerable acreage of this land should be planted with apples in this township. The Pocono sand hills have little soil of any farming value.

BRUSH CREEK TOWNSHIP

Brush Creek township lies north of Union, with the Bedford county line for its western and Sideling Hill for the boundary between it and Belfast and Licking Creek townships. The outcropping strata range from the Mauch Chunk red shales down to the Catskill. The farming land of the southern part of this township is constructed of the same formation, the Catskill, as that of Union township. Six miles north of the southern border of the township the two Pocono ridges, Town Hill and Sideling Hill come together which forms the eastern and western boundaries of Union township and form the township line of Brush Creek. Along this township line northward, the soil is of the Pocono sandstone, is rough and stony with large sections of coarse sandy formations, of little value for agriculture.

Where Town Hill changes its course northeastward the Mauch Chunk red shale remains in a basin which begins just north of the southern boundary of the township and extends northward nearly to the Bedford and Mercersburg pike and forms a valley, having Ray's Hill, the separated part of Sideling Hill, for its western boundary; in which outcrops the Mauch Chunk red shale limestone in a vein ranging from three to five feet thick, containing a stone sufficiently pure for agricultural purposes. The outcrop of this stone and the limy shales it carries with it, show in the timber and other vegetation but especially in farm crops. This limestone outcrops further northwest in Todd township, Huntingdon county, with a thickness of the various red and grey veins composing it of 39 feet. The following analysis give the composition of both the upper or red beds and the lower or grey vein in Huntingdon county.

	Red.	Gray.
Carbonate of lime,	51.785	90.992
Carbonate of magnesia,	1.188	1.059
Oxide of iron and alumina,	3.380	0.940
Siliceous matter,	42.510	6.094
Phosphorus,	.....	0.013
	98.863	99.098

*T2 page 285 and 287.

This may not be the composition of the limestone in this valley, but being from the same formation, it is likely very similar. The soil throughout this section would be much benefitted by the use of lime.

The Bedford and Mercersburg Pike crosses the high divide between Brush and Sideling Hills creeks near the northern border of this township. Along this pike and along the old State road, apple trees grow luxuriantly and bear well. Locust trees seem to thrive here better than any place in the State in a similar formation. This Mauch Chunk limy soil is a splendid wheat soil producing a hard red wheat of superior quality.

WELLS TOWNSHIP

This township occupies the northwestern corner of Fulton county, with the Bedford county line for its western and the Huntingdon county line for its northern boundary. The strata which form the basis of the soils of this township range from the coal measures down to the Catskills. Only a small section of the coal measures remain in the northwestern corner of this township. The sandy and shaly strata overlying the coal veins easily disintegrate and form soils that are easily farmed where the hills are not too steep and are fairly productive. Oats, rye, buckwheat, timothy, and in some places, wheat thrive well. Apple and peach trees look thrifty and bear well. Around the coal basin the Pottsville conglomerate usually forms the crest of the hill, with no farming land, but land well adapted for forests with which most of it is occupied throughout this section.

The Mauch Chunk red shale valley or rolling country throughout this township forms the fertile soil, because, as in Brush Creek Valley, so here the red and grey limestone occurs. Sideling Hill Creek, coming in from Bedford county, flows in a Mauch Chunk red shale country (Ground Hog Valley continued) though surrounded with Pocono hills, and to the south even mountains, the debris of which has covered up some of the soil, still it is fertile. In the vicinity of Wells Tannery Post Office, the Mauch Chunk limestone comes to the surface and its effects are plainly evident.

The country between Elbow Run and Oregon Creek is underlaid with Mauch Chunk red shale and forms the soil of this section. Along Sideling Hill Creek and westward from it, the soil is Mauch Chunk red shale, as is evident from its appearance. Sideling Hill, of Pocono, makes the high ridge to the east of this stream with little or no farming country. At New Grenada, near the northern extremity of the township, the Mauch Chunk limestone again crops out and has been used to make lime. It seems with coal so close by and rather easily obtained that lime could be made at very small cost. These are good wheat, clover, potato, corn, oat, buckwheat and grass soils. It seems that in a section like this that all farm products should be put into the most concentrated form such as butter, pork, beef, lamb and mutton or condensed milk, for shipment.

BETHEL TOWNSHIP

Bethel township lies east of Union and Brush Creek, with the Maryland line for its southern boundary. The strata which forms the basis of its soils range from the Catskill through the Chemung, Portage, Hamilton, Marcellus and Oriskany sandstone into the lower Helderberg limestone. The Catskill Chemung form a strip of soil along the western border on the east side of Sideling Hill made of the soft red shales of this formation. As is usual so here, the softer and more easily disintegrated strata form a country with less steep and more rounded hills than the harder and more sandy surrounding formations. Going eastward, the Chemung conglomerate forms what is known as Black Oak Ridge which passes through Belfast and Licking Creek townships to the north where it forms soils similar in roughness to the soils of the stratum which extends throughout the length of this township west of Pigeon Cove. This conglomerate does not yield to the agencies of disintegration as readily as the shaly Chemung beneath, therefore the steep ridges along side of it and the stony country on top of it. The soil does not seem to be as lean as some other strata of the Chemung but it is rough. A narrow section of Marcellus comes between Tonoloway Ridge which forms the western boundary of Pigeon Cove.

This section is narrow but as usual throughout this part of the State some limy strata occur in connection with it and wherever these enter the formation of the soil some splendid narrow strips of farming land exists.

Tonoloway Ridge formed of Oriskany sandstone on the western side and of Lower Helderberg limestone on the eastern forms the western boundary of Pigeon Cove. This cove extends from beyond the Maryland line somewhat northeastward through the entire length of this township, the soil of which is formed of the Lower Helderberg limestone making one of the most fertile sections of the county. This soil is adapted to all agricultural crops especially for corn, wheat and clover of which large crops under right agricultural practice are usually raised. It should be one of the corn, wheat and clover sections of the State.

The season is sufficiently long in this section to start a crop of winter wheat after the corn is harvested.

The following analysis gives the composition of the limestone near Stillwell Ridge, which forms the eastern boundary of Pigeon Cove. This limestone is sufficiently pure for agricultural and well nigh all other purposes in which lime is required.

Carbonate of lime,	93.117%
Carbonate of magnesia,	2.043
Oxide of iron and alumina,	0,600

Sulphur,	0.075
Phosphorus,	0.006
Insoluble residue,	4.110
	99.95

*Second Pa. Geo. Survey T2, page 274.

Apple orchards have been started throughout the southern and central part of this township which are apparently thrifty.

THOMPSON TOWNSHIP

Thompson township lies east of Bethel and occupies the southeastern corner of Fulton county, with the Maryland line for its southern and the Franklin county line for its eastern boundary. The outcropping strata range from the Catskill through the Chemung, the Portage, the Hamilton, the Oriskany sandstone, the Lower Helderberg limestone, the Clinton shale and the Medina and Oneida sandstone, the latter two of which form the crest of Cove and Dicky mountains. The lower Catskills occupy the highland upon which occurs "Meadow Grounds Mountain," in Belfast and Licking Creek townships to the north of this township and continue southward in a trough through which Licking Creek flows in part of its course southward. Further south several smaller streams flow in this formation, which is hilly, but the soils of which can be farmed and are being farmed. The Chemung conglomerate forms what is known as Timber Ridge, paralleling this formation, which is similar to Black Oak Ridge in Bethel township except, that above the conglomerate, the Chemung shales form a good soil. Further eastward between Timber Ridge and Cove or Tuscarora Mountain, the land is very hilly, but there are some sections where the underlying strata of Lower Helderberg limestone enter into the formation of the soil and wherever this is the case the land is fertile. A Lower Helderberg limestone vein of sufficient size outcrops along the eastern border of this township about two miles north of the Maryland line to furnish lime for the farmers in the Chemung and Catskill soils westward from this section.

The following analysis gives the composition of this limestone.

Carbonate of lime,	87.357
Carbonate of magnesia,	2.346
Oxide of iron and alumina,	1.930
Sulphur,	0.020
Phosphorus,	0.002
Siliceous matter,	8.430
	100.085

*Second Pa. Geo. Survey T2, page 291.

The debris from Dickey Mountain has well nigh covered up all out crops northward from this outcrop. The western part of this township is similar in formation to Bethel township where the Mauch Chunk and Hamilton strata outcrop.

BELFAST TOWNSHIP

Belfast township lies north of Thompson and Bethel, and east of Brush Creek. The strata from which its soils are formed range from the Pocono sandstone down through the Catskill, the Chemung into the Marcellus which outcrops in the vicinity of Needmore in the southern part of the township. Here these shales contain limestone strata which enter into the formation of the soil, but only in a limited way. Eastward the Hamilton sandstone formation follows, and at the Tonoloway Creek, the Portage from bluffs, while above these the Chemung conglomerate, as indicated in the discussion of the previous township forms the ridge, all of which is hilly country, some of it not fitted for farming and therefore should be in forest and where it is not should be reforested. This hilly section extends north, through the entire township. In the eastern part of the township along Scrub Ridge or Licking Creek Mountain the Catskill shales form the soil and while some of it is rough and stony, a large acreage makes good farming land especially adapted to raising apples. Along Licking Creek is some more rolling land, of fair fertility.

Along the northern part of the township is an upland section somewhat more rolling than the surrounding country but some of it rough and difficult to farm. The highland between Licking and Foster's creeks is an extension southward of this section but is not all rough and stony. It seems from the trees growing here at this time that apples could be made a profitable crop on these hills. Black Oak Ridge already referred to in the discussion of Bethel township occupies the country west of Foster's Creek with a rough and hilly section little of which is adapted to farming. The western part of this township, running between Sideling Hill and Black Oak Ridge, the one of Pocono and the other of Chemung conglomerate with some Catskill outcropping, a section probably a little over two miles wide makes a rough and hilly country except where the Catskill outcropping strata forms the soil there is usually land adapted to farming or apple growing.

LICKING CREEK TOWNSHIP

This township lies north of Belfast and east of Brush Creek, with the same underlying strata as Belfast. As already stated, wherever the Catskill strata forms the basis of the soil, there some better

farming land exists than where the Chemung strata prevails. In the vicinity of Saluvia, along the Beford Pike, in this township, a good illustration of this occurs: Here the Catskill covers a larger territory than farther south, making moderately rolling land, which produces a strong growth of forests and farming crops wherever these soils are farmed. The same thing occurs east of Harrisonville, along the same pike, where the Catskills again form the soil. Otherwise the formation of the soil in this township are the same as further south except that in the northern part there is some more rolling land than in the section further south.

TAYLOR TOWNSHIP

Taylor township lies north of Licking Creek and east of Wells township on the Huntingdon county line. The strata outcropping and forming the basis of the soils begin with the Pocono sandstone on the western border of the township and extend through the Catskill into the Chemung. The Catskill strata extends over the entire southern section of this township.

Wooden Bridge Creek rises in the Catskill formation of Wells township and flows eastward into Taylor. The upland along this creek in the southern part of the township about a mile or more north of the Bedford and McConnellsburg Pike are rolling and among the best apple soils in this county. The valley along the creek and where the tributaries join it is broader than creek valleys usually are where the Chemung strata form the banks and therefore some more rolling land occurs here, adapted for raising agricultural crops such as wheat, corn, potatoes, rye, oats but especially timothy hay. Black Oak Ridge shifted its course northeastward as it approached this township and runs along the border between this and Dublin township with some of the soil, in the way of hills and rough country clinging to the eastern part of this township. The Wooden Bridge Creek flows northward along the eastern section of the township into Sideling Hill Creek which flows westward along the northern border. Along Wooden Bridge are some rolling formations with less steep and more rounded hills than in other sections of the county where different underlying strata prevail. Westward beyond Wooden Bridge Creek, through the central part of the township, the Chemungs again hold sway with both of the conglomerate strata occurring in this series taking part in the formation of the soil, and consequently some rough and stony soils are formed of little value to agriculture. The part of the township west of this central section has some Catskill soils but the land is hilly and farming difficult.

DUBLIN TOWNSHIP

Dublin township lies east of Taylor, occupying the northeastern corner of Fulton county, Huntingdon county on its northern and Franklin county on its eastern boundary. The strata from which the soils of the township are formed, range from above the Chemung conglomerate along the western part down through the Portage, Hamilton, Marcellus, the Oriskany sandstone, the Lower Helderberg limestone, the Clinton red shale to the Medina and Oneida sandstone on Cove and Tuscarora mountains. The Chemung and Portage formations are similar to those already discussed in Thompson township. Along Plum Run, in a narrow valley east of the ridge already referred to, and the Oriskany ridge east of the creek, the Marcellus shales form a strip of fertile soil. This soil extends along the outcrop of the Oriskany formation as it follows the lower Helderberg limestone around the nose of Black Log Mountain. Inside of this encircling Oriskany ridge, the Lower Helderberg limestone strata form the basis of a small though fertile section of soil adapted to the raising of all agricultural crops that thrive under the existing climatic conditions. This stone makes a strong agricultural lime as the following analysis will show:

*Carbonate of lime,	91.303
Carbonate of magnesia,	2.043
Sulphur,	0.201
Oxide of iron and alumina,	0.810
Phosphorus,	0.004
Siliceous matter,	5.550
	99.911

*T2 page 304.

Southward and eastward of this limestone formation, the Chemungs hold sway and form a soil better adapted in a few sections to farming than is usual in this county. As already indicated, the nose of the Black Log and the Shade mountains formed of Medina and Oneida sandstone, makes a bold knob near the center of this township, with little farming land on its sides. The soils of the northeastern and eastern parts of the township are formed of the Lower Helderberg limestone, the Oriskany sandstone and the Clinton shale. In the vicinity of Burnt Cabins these three formations make a soil of good fertility and productive capacity, which will produce splendid crops of the cereal grains, while the Clinton formation which contains some fairly fertile agricultural soils it seems from appearances are much better adapted to growing peaches and apples than the regular farm crops.

TODD AND AYR TOWNSHIPS

Todd and Ayr townships lie along the eastern border of the county with the Franklin county line for their eastern boundary. The strata from which the soils of these two townships are formed range in Todd from the Catskill on the "Meadow Ground Mountain" through part of the Chemung, some of the Portage, the Oriskany sandstone, the Clinton shales, along the eastern part of the township, the Medina and Oneida sandstone on Cove Mountain, the Utica and Hudson River shales and the Trenton limestone in McConnell's Cove. The strata of Ayr are all those above enumerated, with the addition of the following: The Mauch Chunk red shale on Meadow Ground Mountain, the Marcellus shale and the Lower Helderberg limestone, the latter two are missing from Todd on account of the Cove fault. The farming soils of Todd township are confined to McConnell's Cove, with the exception of a few small sections in the Clinton shale along the eastern border and in the Hudson River and Utica shale in the northern part of the township, and to the Chemungs south of Knobsville. Cove and Tuscarora mountains, crested with Medina and Oneida sandstone, along the eastern border of the township, are steep, stony and rocky, with little or no farming lands. The Utica and Hudson River shale along the base of the mountain, disintegrate rather slowly on account of which the mountain or hillsides remains steep with land that is difficult to farm and not very productive. All this changes in the limestone cove. The land is moderately rolling, with soils formed of the underlying limestone strata easily farmed, of splendid fertility and great productive capacity. Ayr township in the eastern part is well nigh an exact counterpart of Todd township while in the southeastern part the soil is formed from the Marcellus shale, the Oriskany sandstone, the Lower Helderberg limestone, and the Clinton shale, all of them somewhat limy but still not limestone. These are more especially wheat soils while the limestone will produce all agricultural crops which thrive in this section. Scrub Ridge, with little or no farming land, forms the western boundary of these townships. East of this ridge is Meadow Ground, along which outcrops a ridge of Mauch Chunk limestone, which years ago was burned for agricultural use and which if only ground fine, would likely do as well on these soils as the burned lime. Here is quite an extensive section of land which with some change could be converted into a very profitable summer pasture for young cattle or for milk cows. Blue grass grows luxuriantly where the limy strata form the soil, which if lime would be applied would likely cover the entire section.

McConnellsburg, the county seat, is located in one of the fertile limestone sections of the State, equal in fertility to the limestone valleys of Franklin, Cumberland, Dauphin, Lebanon, Berks, Lehigh and Northampton counties, because the same limestone from which the limestone soils of those counties are formed occurs in this Cove. The farm products of this Cove should be converted by the farmers into concentrated forms, such as butter, milk, pork, lamb, mutton, eggs, poultry, beef and flour and sold by them to consumers through a co-operative organization of the farmers. This county has no railroads at this time but hopes to have several lines in the near future. A few of the elevations above tide are the following: At Sideling Creek 838 feet; at New Grenada, 938 feet; and at Burnt Cabins, 870 feet. These are all localities in the northern part of the county and are fair averages of all farming sections of the county.

BEDFORD COUNTY

Bedford was erected from a part of Cumberland county by an Act of Assembly, March 9, 1771. It contains 656,640 acres, of which 465,916 acres is land in farms, and of which 264,814 is improved farm land. Thirty thousand five hundred and sixty-two acres were planted with corn in 1909, yielding 855,100 bushels; 18,262 acres were sown with oats, yielding 388,061 bushels; 23,392 acres with wheat, yielding 333,871 bushels; 10,869 acres with buckwheat, yielding 156,207 bushels 10,213 acres with rye, yielding 101,158 bushels; 2,825 acres were planted in potatoes, yielding 263,790 bushels; 35,985 acres were sown with all forage crops, yielding 42,018 tons of various kinds of hay. Of the 264,814 acres of improved farm land, 132,108 were used for raising farm crops, while 132,706 were not so used and were likely producing weeds. At this time Bedford county had a population of 38,879 people to feed, 27,109 cattle, 10,013 horses, 342 mules, 20,317 swine and 22,112 sheep.

SOIL FORMATION

The geological formation begins with the Trenton limestone, which forms Morrisons, Friends and Millikens Coves, renowned for their fertility, and ends with the coal measures No. 13, all of them having a thickness of 22,070 feet. Three railroad systems, the P. R. R., the H. & B. T. R. R., and B. & O. R. R. enter the county, the first traverses the county from north to south, the second begins at Bedford across to Everett, and thence to the Broad Top coal field, and the last comes in from the south and crosses into Somerset county, at Wills Creek Gap, west of Hyndman.

Beginning with Mann township in the southeastern corner of the county, the Catskill, Hamilton, Portage and Chemung shales form the soils. The Chemung soils formed of the strata below the upper conglomerate are not as fertile as those above it but are well adapted for potatoes and within recent years potato growing has been made a crop that has been yielding fair returns in the more loamy soils of the township. Apple growing has also been begun with good promise of success.

SOUTHAMPTON TOWNSHIP

Southampton township lies west of Mann with the Maryland line for its southern boundary. The strata from which the soils of this township are formed range from the base of the Catskill in the northeastern part of the township through the Chemung on Ragged Ridge, through the Portage on Polish Ridge, the Hamiltons along the hillsides, the Marcellus shales along Warriors Ridge, the Oriskany, which, together with the Lower Helderberg, forms this ridge, the Clinton shales and the Medina and the Oneida sandstone.

When it is stated that all these formations outcrop within a distance of between six and seven miles, it is evident that there has been some twisting of the strata in this part of the county, and that some hilly and rough country exists, with soils of very mixed origin. The eastern part of the township, with Ragged Mountain and Polish Mountain close to and within its boundaries, is hilly, with land that is difficult to farm and not very productive. The land on the east side of Warriors Ridge, formed of the Marcellus shale and some Oriskany sand and the Lower Helderberg limestone and the Clinton shale, with some Medina debris, are sometimes rough and stony and difficult to farm, but where disintegration has proceeded far enough to form gravels and loams, these soils are productive. Along the hillside of Bean Cove, along which the Clinton shale make a terrace of some width, should exist among the best peach soils in this section, or for that matter any section. Within the Cove the Lower Helderberg limestone, the Oriskany sandstone, Clinton and other debris forms the soil, which is fertile and productive. Wheat, corn, potatoes, the clovers all thrive, especially wheat in the more clayey soil and potatoes in the gravelly types. Martins Ridge forms the central part of Bean Cove.

MONROE TOWNSHIP

Monroe township lies north of Mann and Southampton and has the Fulton county line for its eastern boundary. The strata from which its soils are formed are the same as those of Mann and Southampton. The Catskill strata form the basis of the soil along the west side of Rays Hill and on both sides of the east branch of Sideling Hill Creek, where they make a valley between Rays Hill on the east and Addison

Ridge on the west. The land here is more fertile, more moderately rolling and more easily farmed than among the Chemungs. The little town of Robinsonville is located in this valley. West of the valley, as already indicated, is Addison Ridge between which and Hoop Pole Ridge, the west branch of Sideling Hill Creek flows and makes a valley of Chemung shales, with some farming soils of fair fertility. On both these ridges the Chemung upper conglomerate occurs. West of Hoop Pole Ridge is Raccoon Ridge with very similar strata to those already referred to. Between Raccoon and Snyders Ridge, a branch of Piney Creek makes a valley in the southern part of the township. West of the ridges, referred to, a trough or a downward curve of the strata retains the Catskill formation, while on the eastern edge of this trough Black Oak Ridge, formed by the underlying Upper Chemung conglomerates, and further west the top shales of the Chemungs which, together with the Catskills, make a rolling country, with some fairly fertile farming land that will respond wonderfuly to liming and manure. This formation extends through the township from north to south. The two forks of Clear Creek make a broad rolling section in which the Hamiltons form a ridge, but below which likely the Marcellus have disintegrated and made the rolling soil a possibility. The soil here at any rate seems as if it was made of superior materials. Warriors Ridge extends through the entire township, east of which, as already indicated, the Marcellus shale forms the basis of the soil, while west of it the Lower Helderberg limestone and the Clinton shale with some Medina debris, make up the soil as stated before.

EAST PROVIDENCE TOWNSHIP

East Providence township lies north of Monroe on the Fulton county line. The Pocono along Rays Hill and the Catskill, with a small section of Upper Chemungs form the soils of East Providence. Addison Ridge, or what remains of it, extends into this township. East of this ridge, in the southeastern corner of this township, is a rolling upland of Catskill with some conglomerates which seems to have a soil and climate adapted for raising apples. The Upper Chemungs form the soil on Addison Ridge as far north as Brush Creek and a more rolling country than the Lower Chemung, with a richer soil. Similar formations occur in the southern part of the township which becomes more hilly as the Pocono Ridge, surrounding Broad Top township, is approached. The Raystown Branch of the Juniata makes a curve into this township. This township has soils very similar to those of the northeastern counties of the State where apple growing seems to be the crop for which the soils are best adapted.

WEST PROVIDENCE TOWNSHIP

West Providence lies west of East Providence and north of Monroe. The strata from which its soils are derived range from the Catskill down through the Chemung, the Hamilton, the Marcellus, the Oriskany sandstone, the Lower Helderberg limestone, the Clinton shales to the Medina and Oneida sandstone. The Raystown Branch of the Juniata River cuts a very circuitous course through the eastern part of this township, along which in the numerous curves are some alluvial soils of better fertility than the surrounding hills, adapted to all agricultural crops. Along the greater part of the river the sides are steep and no land of any agricultural value exists. The Chemung, except where the upper strata and the Catskill form the soil, makes a steeper hilly country, running parallel with the Catskill throughout the township. Along the western part of this township where the Marcellus, the Oriskany, the Lower Helderberg limestone and the Clinton shales form a mixed soil, the land is more fertile; especially is this true in the vicinity of Everett and thence northward to Tatesville, the northern extremity of the township.

HOPEWELL AND LIBERTY TOWNSHIPS

Hopewell and Liberty townships lie, the former north of West Providence, and the latter north of the former, with the Huntington county line for part of the northern and northeastern boundary. These two townships have soils formed from the same underlying strata, namely, the Chemung, beginning above the conglomerate, the Hamilton, the Marcellus, the Oriskany sandstone, the Lower Helderberg limestone, the Clinton shale and the Medina and the Oneida sandstone.

From Tatesville eastward is a high ridge upon which the Chemung conglomerate forms the surface. This ridge continues northward through the two townships, accompanied on the east by the Catskill strata above the Chemung, followed by the Pocono and the Mauch Chunk red shale and the conglomerate. There is not much farming land along the entire eastern line of these two townships, except small sections in the Mauch Chunk and the Catskills and at such places as Hopewell along the river. Westward of the Chemung and Hamilton Ridge of Oriskany sandstone and the Lower Heidelberg limestone and the Clinton shales outcrop, the land is less hilly and the soil fertile. North of Tatesville, along Pipers Run, is the same moderately rolling land with soils of Clinton shale of fair fertility. Along the road running through the Gap out of the southern and of Morrisons Cove to Hopewell, in Hopewell township are similar soils that produce well all agricultural crops. Northward through

the valley, formed on the Marcellus, the Oriskany, the Lower Helderberg and the Clinton in Liberty township, even more fertile farming lands occur.

Surrounding this entire section is Tussey Mountain, of Medina and Oneida sandstone, with terraces where the Clinton shales remains on the mountain side, adaptations for which have already been given.

BROAD TOP TOWNSHIP

Broad Top township occupies the northeastern corner of this county, with Fulton county on its eastern and Huntingdon on its northern boundary. The strata from which its soils are formed range from the coal shales down through the conglomerate, the Mauch Chunk red shale into the Pocono sandstone which forms a strip of highland along the southern and western border. Sherman's or Ground Hog Valley, along which Sherman's Run flows, extends along the southern border with a soil formed of the underlying Mauch Chunk red shale mixed with limy strata and with the debris from the Pocono Ridge on the south and the conglomerate on the north. This same formation extends along the western border of the township with red limestone outcroppings forming a superior soil wherever the poor Pocono and conglomerate do not adulterate it too much. The coal shales and sandstone strata of the coal measures, in the trough of the conglomerate, wherever the shales prevail form loamy and sometimes clayey soils of fair agricultural capacity, though apparently deficient in phosphoric acid and nitrogen. The two former should be supplied while the latter should be produced through the agencies of the clovers.

The sandy loams seem, from the thriftiness of the trees growing at this time, especially adapted for apple and peach raising, as well as timothy, rye, buckwheat, potatoes, oats and early ripening corn. The elevations range from 1,700 to 1,990 feet above tide on Broad Top.

COLERAIN AND SNAKE SPRING TOWNSHIPS

Colerain and Snake Spring townships are located in Friend's Cove north of Bean Cove, in Southampton township, surrounded by Evitts and Tussey mountains. The soils of these two townships range from the Medina and the Oneida sandstone on Evitts and Tussey mountains down through the Hudson River and Utica shales into the Trenton limestone. The Cove is a broad valley, the greater part of which is underlaid with the Trenton limestone, the same limestone that form the fertile soils of Cumberland and other counties in the southeastern part of Penna., and squally as fertile as those of the eastern counties where they are made of the underlying limestone. These township are surrounded, as already stated,

by Evitts and Tussey mountains with summits ranging from 1,744 to 1,915 feet above tide, while within the valley is a protected section of much lower elevation.

Through the central part of this valley runs a ridge the soils of which are in harmony with the underlying rock, where the Utica and the Hudson River shales prevail the soil is loamy, where the ridge rises sufficiently high as it does in the northern part of it to catch some of the Oneida and Medina sandstone the soil is sandy and where little if any of the above formations remain as is the case in some places in the south central part of the ridge the soil is stony, mixed with limestone and the remains of the overlying strata. Along this ridge, from indications, are splendid fruit soils. Cove Creek flows in a broad valley close to the base of the ridge along the eastern side of the Cove with a fertile soil, made in some places of alluvial and deluvial deposits, while the hillsides of the ridge within the Cove and that along the outside, as already indicated, are made of the underlying strata.

The following analysis gives the composition of a sample of limestone selected along the eastern side of the Cove north of Rainsburg:

2 page 163.

Carbonate of lime,	90.589%
Carbonate of magnesia,	1.929%
Oxide of iron and alumina,	0.590%
Sulphur,	0.018%
Phosphorus,	0.005%
Insoluble residues,	6.410%
	99.541%

The southern part of the Cove is nicely rolling, with numerous streams flowing through it and with soils largely limestone and of mixed origin, but invariably fertile. Along the west side of the Cove the valley is narrower in some places and plained down as it is along Cove Creek, but the soil is where underlaid with limestone equally as fertile. Along the river on the south side near the railroad are numerous outcroppings of the limestone which, with the coal from Broad Top or from Somerset county, could be burned for lime at a comparatively low cost. On the northern side of the river limestone occurs in many places.

At Willow Grove and east of this section, and northward, the limestone valley narrows and the Utica and Hudson River shales form the soils, except along Valley Run, where the limestone forms some small sections of soil. This Cove is within fairly easy reach of good

markets, but still sufficiently distant to make shipments of bulky farm products a matter of consideration, and therefore, farm products should be converted into concentrated form such as butter, milk, pork, lamb, mutton, beef, flour, etc., and should be handled by the farmers co-operately so that they might realize such returns from their farming operation as would be an inducement to greater effort while at the same time they could make their soils more productive.

MORRISON'S COVE

Morrison's Cove, containing South Woodbury, Woodbury, and Bloomfield townships, lies north of Snake Creek township, east of Hopewell and Liberty, with the Blair county line for its northern boundary. These townships contain the same underlying rock strata as Colerain and Snake Creek, namely the Medina and Oneida sandstone in the surrounding ridges of Tussey Mountain accompanied by the Hudson River and Utica shales with the Trenton limestone underlying the Cove. It must be remembered that this limestone formation of about 4,500 feet in thickness is not all pure limestone; the likelihood is that nearly half of it is more or less sandy and cherty (a term meaning an impure flinty rock or stone).

Another thing must be remembered in the discussion of these soils, that not the whole of the overlying shales and sometimes even sandstones have been removed and these enter into the composition of the soil and change it physically and chemically as well as in productive capacity. This latter condition prevails especially along the base of the mountain on the south as well as on the east and west side of the Cove. Coming into the Cove from the south along Beaver Creek, Evitts Mountain makes a curve and changes its northward course to a westward course. Along the border of this southern mountain the Hudson River sandstones enters into the formation of the soil. Along here the land is hilly, the soils wash readily and are not productive. But within a short distance north of this Hudson River formation, the upper comparatively pure limestone, as the following analysis will show, comes to the surface and a gently rolling country is formed with soils of splendid fertility.

T2 page 171.

Carbonate of lime,	90.857
Carbonate of magnesia,	3.216
Oxide of iron and alumina,	0.360
Sulphur,	0.103
Phosphorus,	0.006
Insoluble residue,	5.130
	99.672

A number of anticlinals or upward curvatures of rock strata pass through these townships in a northeasterly direction and these bring to the surface lower and more sandy strata and these in turn make a more sandy soil not as rich in lime, and as clayey as the soils formed of the pure limestone, but as rich or probably even richer in other fertilizing elements. It is certain that these more sandy and sometimes cherty and stony soils are not as difficult to farm as are the clayey limestone soils, and that with the introduction of vegetable matter by plowing down sods and the frequent and not too heavy application of manure they will produce equally as large crops of cereal grains of heavier weight bushel for bushel, as the clay soils will.

A splendid illustration of these different formations is afforded in a ridge which has its beginning in South Woodbury township and extends from Beaver Creek northward to Bloomfield township where another ridge, coming northeastward, joins it, making the united ridges more than a mile wide. In Bloomfield township this ridge is known as the "Barrens." It extends into Blair county. It has a sandy soil which in some places is lean and not very productive but other parts, especially where the limestone strata co-mingle with the sandy, the soil is productive.

With this and a few minor exceptions, the soil of Woodbury and Bloomfield townships range among the richest in the State, adapted to raising all agricultural crops that will thrive in this climate. These soils will admit of the most intensive type of farming. The markets of the coal regions already take all that intensive farming can produce here. In the Hudson River, Utica and Oneida and Medina strata which, as already indicated, surround this Cove, are some agricultural sections of as good productive capacity as the limestone, but they are usually surrounded with rough and hilly formations and not as accessible as the moderately rolling limestone sections. Here, however, are fruit soils that are equal to the best in the State and they should be used for raising these crops.

CUMBERLAND VALLEY AND BEDFORD TOWNSHIPS

The former lies west of Southampton and Colerain townships on the Maryland line, while the latter lies north of the former and west of Colerain and Snake Spring townships. The rock strata from which the soils of these townships are formed begin with the Chemungs and range down through the Portage, Hamilton, Marcellus, Oriskany sandstone, Lower Helderberg limestone, the Clinton shales to the Medina and the Oneida sandstone.

Evitts Mountain forms a ridge of Medina and Oneida sandstone along the eastern border of these two townships for a distance of thirty miles, and Will's Mountain, with the same strata, for a dis-

tance of twenty-five miles along the western border. A narrow section of Clinton shale and Lower Helderberg limestone parallels these ridges on both the eastern and the western side of the valley, while the Oriskany sandstone and the Marcellus shale forms a central, though frequently broken ridge between the eastern and western Lower Helderberg sections in Cumberland Valley township.

The northern boundary of Bedford township is a ridge of Medina sandstone. All these formations occur within an approximate distance of about five miles on the ridges and along their slopes so that the soils throughout the length of Cumberland Valley township are derived, what soil there are, on the ridges of the Medina, on the side hills from the Clinton and Media debris while the Clinton and Lower Helderberg limestone and the Oriskany make a mixed soil of good fertility, especially in the Cumberland Valley where the limestone and the limy shale strata are more abundant than the Clinton and the Oriskany. These limy shales and the limestone, with the intermixed sandstone, make among the best wheat, clover and potato soils in the county. Alfalfa has been raised in this township for a number of years with splendid results. Cattle feeding is one of the agricultural industries in a few sections in this township. An operation of this kind came under the observation of the writer in which alfalfa, hay, corn silage and a small amount of corn chop were the rations with which a gain of two pounds a day were made during the feeding period. This it seems should be the industry that should be encouraged throughout this valley. The Oriskany sand ridge, known as Knobbly Mountain, running through the central part of the valley, is a succession of knobs rising from 300 to 500 feet above the surrounding valleys with some splendid apple soils on their sides. In many places throughout this valley forest growth is immense with usually an impenetrable undergrowth.

At Bedford, the county-seat of Bedford county, the area of the Lower Helderberg limestone widens and forms a rolling country with soils of splendid fertility, easily farmed and adapted to growing all agricultural crops such as corn, wheat, oats, the higher and thinner soils rye and buckwheat. All the clovers thrive here especially alfalfa seems can be raised with little difficulty.

The same strata already referred to in the discussion of the Cumberland Valley prevail in the circuit formed by the Medina sandstone ridge connecting Evitts and Dunning mountains which forms the northern boundary of Bedford township. These strata, the Clinton, the Lower Helderberg and the Oriskany make a mixed soil of a high type of fertility where disintegration has proceeded far enough to form loamy soils.

All kinds of crops agricultural and horticultural thrive here. Inside of this semi-circular area, already referred to, a little distance north of Bedford the Oriskany sand, the Marcellus shale, the Hamilton and the Chemung remain because of the flattened upward curve of Wills Mountain, west of Bedford and the curving of the course of Evitts Mountain eastward, east of Bedford and form soils characteristic of the formations already described and to be referred to again. The soils surrounding Bedford are among the most fertile in this formation anywhere in the county.

LONDONDERRY TOWNSHIP

This township lies west of Cumberland Valley and occupies the southwestern corner of Bedford county, with the Maryland line for its southern and the Somerset county line for its western boundary. The outcropping strata extend from the Pottsville conglomerate on Savage Mountain down to the Hudson River shales at the southern end of Millikens Cove.

All these formations outcrop within a distance of about three miles, which to any one acquainted with geological formation know, that a wonderfully hilly country must exist here, which is the case. The soils that do exist are formed of mountain debris and disintegrated materials of underlying strata of the Clinton, the Lower Helderberg, the Oriskany and what little Marcellus may occur located in the valley of Mills Creek. A very pure limestone occurs in this valley of which the following analysis gives the composition.

Carbonate of lime,	98.178
Carbonate of magnesia,	1.854
Oxide of iron and alumina,	0.114
Sulphur,	0.020
Phosphorus,	0.007
Insoluble residue,	0.230
	100.403

A considerable quantity of limestone occurs here which years ago was shipped away for use in iron manufacturing. It seems that it would be possible to make lime at small cost here with coal from Southampton township, Somerset county. Northward at Hyndman the valley becomes narrower than between Palo Alto and Hyndman and the country as hilly or even more so than further south. At Fossilville the same condition continues.

HARRISON TOWNSHIP

Harrison township lies north of Londonderry and west of Cumberland Valley and Bedford townships. The outcropping rock strata range from the Catskill down to the Trenton limestone which out-

crops in Millikens Cove. The Hudson River and Utica shales, with some debris from the Medina of the surrounding mountains and with some of the effects of the underlying limestone forms the soil of the cove which is not very productive, except in the central part of the valley.

Buffalo Valley, with the Clinton, Lower Helderberg, Oriskany and Marcellus shales, crosses this township in a northeasterly direction with soils similar to those already described. The Lower Helderberg limestone outcrops north of Bard where it has been quarried and lime burned of it. The following analysis gives the composition of this stone:

T2 Page 112.

Carbonate of lime,	92.875
Carbonate of magnesia,	1.891
Oxide of iron and alumina,	0.370
Sulphur,	0.030
Phosphorus,	0.005
Insoluble residue,	4.810
	99.981

This stone will burn into pure lime, just the thing for the Hamilton and Chemung shales of which the soils of the western part of this township are made. The soil of the hills throughout this part of the township is usually thin. Along the streams they are usually productive but the valleys are comparatively narrow and therefore the acreage is small.

JUNIATA TOWNSHIP

Juniata township lies west of Harrison on the Somerset county line. The strata from which the soils are formed are the Catskills and the Chemung and the Hamilton, not a very good combination. The Catskill and the Upper Chemung make some fair soils here which produce the hay grasses, such as timothy, and among the grain, rye, oats and buckwheat, and wherever lime is applied, wheat and clovers thrive. Apple trees look thrifty but there are but few in existence.

NAPIER TOWNSHIP

This township lies north of Juniata and Harrison townships on the Somerest county line. The strata from which the soils are formed range from the Pocono sandstone along the Allegheny Mountain into the Clinton shale along Buffalo Mountain. A small nose like projection of this township extends into Wills Mountain. Directly west of this mountain the Clinton shales, the Helderberg limestone and the Oriskany sandstone form the bottom land of the Raystown

Branch of the Juniata River, which makes fertile farming land throughout this section. Westward from this place the Hamilton sandstone prevails along the river and forms a valley of less fertility and not as wide and with steeper hillsides.

West of the Hamilton the Chemung shales form a hilly country caused by the northward extension of Savage Mountain. Spring Valley, made of Marcellus shale and limestone lies west of this and extends into St. Clair township. Chestnut Ridge, covered with limy gravel, with a soil upon which grows magnificent chestnut, white oak, red oak, black oak and several other varieties of timber. Some original forests of this type still exist here. This gravely soil formation encloses a Lower Helderberg limestone valley which extends from near Schellsburg, in Napier township, on the south to Spring Meadow P. O. in West St. Clair township. This Lower Helderberg limestone contains among the most productive soils in the county. The limestone gravel, already referred to, especially when it contains organic matter and some well disintegrated material, is a very productive soil never too wet nor too dry to plow or cultivate and neither does the soil become so dry or wet that plants will suffer for water or on account of having too much of it.

The Dunning Creek Valley along the western border of this limestone, is formed on the Marcellus shales and contains fertile soil. West of this valley the country is hilly with only small sections suitable for farming.

EAST ST. CLAIR TOWNSHIP

East St. Clair township lies north of Napier and west of Bedford with the same underlying strata as Napier, except that no Pocono or Catskill occur within its limits. The same Clinton, Lower Helderberg, Oriskany and Marcellus strata, already described, occur along the easter border of the township, and from Black Oak Ridge, and at such places as St. Clairsville and Renoldsdale, the land formed by the disintegration of these formations is low and seems to need underdraining, while westward where formations not so readily affected by the agencies of disintegration form hilly land.

The same thing occurs at Cessna, except that the limestone remains here with a sufficient outcrop to make lime. Westward of these places the country is more or less rolling, with soils formed of the Hamilton, Genesee and the Chemungs. This is the case at Fisherville and vicinity. West of the Chemung, this township contains a section of the Lower Helderberg limestone valley extending about Spring Meadow, already sufficiently described, except that lime has been burned of the limestone in this township.

WEST ST. CLAIR TOWNSHIP

West St. Clair township lies west of east St. Clair along the Somerset and Cambria county line. This township also contains a section of the Lower Helderberg valley and the valley of Dunning Creek, already described. Westward from this place the Chemung strata prevail until the Catskills are reached. This country is hilly with the exception of an upland approximately in the central part of the township where the land is rolling and can be more easily farmed. Big Bald Knob, 3,000 feet above tide, is on the border line between this and Somerset county.

UNION AND LINCOLN TOWNSHIPS

Union township lies north of West St. Clair and Lincoln lies north of Union, both on the Cambria county line, the latter occupying the northwestern corner of the county. Only the Pocono, the Catskill and the Chemung strata outcrop in these townships. The township is very hilly and farming operations are attended with many difficulties and do not yield returns that are encouraging. Blue Knob, 3,136 feet above tide is located in Lincoln township.

KING TOWNSHIP

King township lies north of East St. Clair and west of South Woodbury and Bloomfield. The outcropping strata range from the Chemung down to the Medina. Dunning Mountain, of Medina sandstone, forms the eastern boundary of the township. Below it the Clinton shales, together with mountain debris, form a soil of some agricultural value. The limestone valley between this and Pine Ridge contains a fertile soil equal to any in the county. West of Pine Ridge is Innler's Valley made of the limy Marcellus shale which is also fertile and adapted to the raising of agricultural crops. In the southern part of this township and the northwestern corner of East St. Clair and partly in the northeastern corner of West St. Clair is a fertile section of rolling country with soils largely formed of the Marcellus shales. West of Innler's Valley the Hamilton sandstone form Long Ridge. West of this the Chemung lower conglomerate form a stony section.

Bedford county, as already stated, has a total thickness of 22,070 feet of outcropping rock strata ranging from the highest stratum on the Broad Top coal field down to the lowest outcrop of the Trenton limestone in Friends Cove on the Rays Creek Branch of the Juniata. This means a large variety of soils types of varied fertility and productiveness, all of which must be studied and made available for the use of man as well as the preservation of the soil.

DRAINAGE

The central and northern part of the county are drained by the Raystown Branch of the Juniata which rises in Somerset county and flows eastward through approximately the central part of Bedford nearly to the eastern line when it turns northward into Huntingdon county. Dunning's Creek, draining the northwestern part of the county, flows into the Raystown at Evitts Mountain. Brush Creek, rising in Fulton County, flows into the Raystown near where it changes its course northward, drains the south central part of the county. These, with a number of smaller streams flowing from the north and the south, drain these parts of the county while the streams flowing south into the Potomac, beginning in the western part of the county are Wills, Evitts, Flintstone, Town, and Sideling Hill creeks. The elevations above tide range from 774 at Cook's Mills, in Londonderry township, 2,609 on a bend of the Allegheny Mountain in St. Clair township. The elevation of the farming land ranges between 1,000 and 1,100 feet. The railroad facilities of the county are somewhat limited; but with the right co-operation by the farmers with the railroad and the railroad with the farmers, the transportation facilities can be arranged as the demand for transportation increases.

BLAIR COUNTY

Blair county was formed from parts of Huntingdon and Bedford by an Act of Assembly, February 26, 1846. It contains 341,760 acres, of which 176,513 acres is land in farms, and of which 117,669 acres is improved farm land. 14,996 acres were planted with corn in 1909, yielding 405,207 bushels; 11,602 acres sown with oats, yielding 267,602 bushels; 13,861 acres with wheat, yielding 225,646 bushels; 1,753 acres with buckwheat, yielding 20,422 bushels; 2,439 acres with rye, yielding 26,905 bushels; 2,350 acres planted with potatoes, yielding 182,278 bushels; 23,201 acres sown with all forage crops, yielding 27,088 tons of the various kinds of hay. Of the 117,669 acres of improved farm land, 70,205 were used for raising farm crops, while 47,464 were not so used and were likely producing weeds. At this time Blair county had a population 108,858 people to feed, 14,000 cattle, 5,070 horses, 164 mules, 9,754 swine and 6,731 sheep.

Blair county lies south of Center, west of Huntingdon, north of Bedford and east of Cambria. The outcropping strata from which the soils of this county are derived, range from the Pottsville conglomeration and coal measures through the Mauch Chunk red shale, the Pocono sandstone, the Catskill red sandstone, the Chemung

shales, the Portage flags, the Hamilton shales, the Oriskany sandstone, the Lewistown limestone, the Clinton shales, the Medina and Oneida sandstone, the Hudson River and Utica shales, down into the Trenton limestone. The Juniata River drains the county from all directions. It rises in the foothills of the Allegheny Mountains, in the northwestern township of the county, while the little Juniata rises in the northeastern township. It is obvious, from the statement above made, that this county, like Huntingdon, Center, Clinton, Bedford, Perry and Fulton has an enormous thickness of geological strata amounting to 23,000 feet, according to the 2nd Geological Survey, Vol. T and also that its topography harmonizes with its geological formations, the limestone making the broad valleys such as Morrison's Cove and Canoe Valley, the slates making the smaller and narrower valleys with steep hillsides while the upper members of the Medina sandstone, the Catskill and the Catskill and the Pocono sandstones make mountains.

NORTH WOODBURY TOWNSHIP

This township occupies the southeastern corner of the county, with Bedford county for its southern and Huntingdon county for its eastern boundary. The soils of this township are derived from the Medina and Oneida sandstone, the Hudson River shales, the Utica slates and the Trenton limestone. The Medina red sandstone makes an escarpment along the mountain on the eastern border of this township which is considerably lower than the crest of the mountain with rather deep, stony and sandy loams with sufficient water and fertility holding capacity to make rather valuable forest land, and if farmed well, the less steeply hilly sections would with such crops as the winter vetch and rye grown as an early summer fertilizing and organic matter producing crop, produce vigorous apple trees which will yield fairly large crops of well developed, nicely colored and flavored fruit. But it were better where so large an acreage of land, better adapted for farming and fruit growing than these soils, is not used, that timber should be raised here.

Beside the escarpment made by the softer Medina red sandstone and shaly rock, the Hudson River shales make a second escarpment lower down the mountain as well as a more rolling section extending to the limestone valley. Both of these escarpments as well as the more rolling sections are cut through by smaller streams by the side cutting of which more or less broad valleys have been made so that these escarpments and the more moderate slopes have become a corrogated mountain side.

Upon the higher elevations of these corrogations are sections of rolling land with fairly deep, warm, early spring farming soils where late summer or even late fall sown, early summer ripening crops such

as winter vetch, crimson clover and the red and alsike clovers among the legumes, and rye, wheat, and probably winter oats among the fall sown cereal grains can make an early start and ripen before the dry weather of July and August sets in. These soils can also be plowed early and even wet and be sown with such crops as oats and Canada field pea, and when dry they will not become cloddy and these crops could probably be ripened before the dry weather sets in, which usually reduces yield very materially. It seems that these soils should be well adapted for raising winter vetch and crimson clover seed and such monetary returns realized from the sale of the seed as to make this an inviting financial proposition while the growing of these legumes would mantain or probably enhance the productive capacity of these soils. A rotation could be readily worked out in which these seed crops would occupy the financial as well as the soil improving position. In the southeastern corner of the township the shaly formation is wider with a larger area and a more rolling section with deep warm early spring farming land adapted for raising the legumes such as alfalfa red and alsike clovers and the cereals such as wheat.

The limestone valley of this township is a continuation of Morrison's Cove, the soils of which are derived from the decomposition and disintegration of the underlying Trenton limestone. The loamy types of soils prevail, with clay loams and clays in the more level sections. The land is moderately rolling with some nearly level sections as well as some more steeply rolling, with deep soils, with large water and fertility holding and crop accommodating capacity. The loamy types when they contain a considerable quantity of organic matter, with the natural drainage these soils usually have, are warm, can be cultivated early and are adapted for raising the regular farm crops, but especially adapted for raising corn, wheat and oats, but more especially corn and wheat, and the legumes, alfalfa red, alsike and Mammoth clovers among the perennials, and winter vetch and crimson clover among the fall sown annuals, and Canada field peas, soja beans and likely the cowpeas among the spring sown annual legumes. The loamy types of these soils throughout this township are sufficiently warm for late summer or even late fall sown early summer ripening crops to make an early start in the spring especially when the soils contain a considerable amount of organic matter or the soils can be prepared early so as to sow or plant such crops as oats, barley and peas sufficiently early so that the plant can make a sufficient growth to produce a crop before the extreme hot and frequently dry weather of the middle of July sets in. In fact these soils have so large a crop accommodating capacity that early or late fall sown winter crops that will ripen early in the following summer such as the winter vetch and the crimson clover among the legumes and rye among the

cereal grains can be harvested, the rye and vetch for hay and the crimson clover for seed, the land prepared and planted with a Ninety-Day corn or with silage corn the one harvested for gain and the other for roughage or a crop of crimson clover or vetch can be plowed down and the land prepared and planted with corn or the soja bean or the cowpea, these harvested and the land sown with wheat or vetch and rye or with crimson clover in the corn, and in this way a growing plant can be on the land at all times and advantage taken of the entire growing season beginning with the cool weather early summer ripening crops and continuing with the hot weather late summer and fall ripening crops. With such an arrangement the production of this land can be made twice what it now is, and with the right use of the manure and by the raising of these soil improving crops, the fertility maintained or even improved.

TAYLOR TOWNSHIP

This township lies west of North Woodbury, with the Bedford county line for its southern boundary. The soils of the township are derived from the same underlying rock as those of Woodbury township, except that a larger area of the sandy formation of what is known as the "Barrens" occurs in the southeastern part of the township with sandy loams, sandy and stony soils. These, because of the depth of sand and low capillarity, are wet weather soils, producing in the loamy types fairly large crops when sufficient rain falls during the growing season to keep up the water supply; but when this is not the case crops soon suffer for water and yields are reduced below the remunerative condition and agricultural operations are not inviting. These soils can be farmed much earlier in the spring than those derived from the limestone formation. Advantage should be taken of this property and such farm or truck crops raised as will ripen during the season of sufficient rains, and then the land sown with a dry weather plant such as Kaffir corn and the cowpea. The sandy and stony areas of this formation should be used for raising timber for which it seems splendidly adapted.

HUSTON TOWNSHIP

This township lies northeast of North Woodbury with the Huntingdon county line for its eastern boundary. The soils of this township are derived from the limestone, the Utica slates, the Hudson River shales and the Oneida and Medina sandstone, with quite an area of the sand formation previously referred to and therefore the soils are very similar to those previously discussed, except that two ridges of soils derived from the more stony formation of Hudson River origin occur in the southern part of the township and extend

northward approximately to the central part. Along the sides of these ridges the soils are dirved from a combination of both the limestone and the rock from which the ridges are formed and are deep, warm, early spring farming soils equally as fertile as the limestone and can be farmed considerably earlier and crops given a start that will, when an adverse late season occurs, produce larger yields. The clay loams and the clay soils derived from the underlying limestone in these three townships have a larger water and fertility holding capacity but can not usually be farmed as early as the loams but crop yields will usually be as large or even larger than any of the soils throughout this formation because of the greater capillary capacity of these soils and therefore the greater area from which to obtain both moisture and fertility.

WOODBURY TOWNSHIP

This township lies north of Huston, along the Huntingdon county line. The soils of the township are derived from the same underlying strata as those of the township previously discussed, with a larger area of the sandy soils than any of the townships previously discussed. The formation extends from Huston into Woodbury.

CATHARINE TOWNSHIP

This township has Tussy Mountain, which forms the boundary between Blair and Huntingdon counties, for its eastern and the Huntingdon county line for its northern boundary. In the eastern part of this township the soils are derived from the same geological formations as those previously discussed, the limestone, the Hudson River and Medina formations. The analysis of samples of limestone from this township and from Taylor shows the similarity in composition and the quality for agricultural lime.

Analysis.—	Catherine	Taylor
Carbonate of lime,	94.98	91.892
Carbonate of magnesia,	3.866	2.875
Oxide of iron and alumina,	0.264	0.640
Sulphur,	0.053	0.097
Phosphorus,	0.011	0.022
Insoluble residue,	0.910	4.380

Pa. 2nd Geographical Survey M. M. Page 306 and 307.

Besides the limestone the dolomite or magnesia limestone also occurs in the Trenton formation as the following analysis of samples of stone from a quarry near Tyrone in the northern part of the county will show.

Analysis.—

Carbonate of lime, ...	48.030	53.870
Carbonate of magnesia, ...	37.670	41.320
Oxide of iron and alumina, ...	2.850	1.190
Sulphur, ...	0.463	0.040
Phosphorus, ...	0.042	0.013
Insoluble residue, ...	10.380	2.910

The soils in Canoe Valley are derived from the Clinton shales. Brush and Canoe mountains with soils derived from the Oneida and Medina sandstone and with the escarpments previously referred to, bound Canoe Valley. The valley is narrow, but the soils are fairly fertile and will be discussed with the township having a larger area of soils derived from this formation.

TYRONE TOWNSHIP

Tyrone township lies west of Catharine, with the Huntingdon county line for its northern boundary. The soils of the township are derived from the Trenton limsetone, which underlies Sinking Valley, the Utica and Hudson River formation and the Oneida and Medina sandstone. In the southwestern part of the township, where Brush and Bald Eagle Mountains come to a point, is a section of rolling high land, with stony, loamy soils, derived from the more easily disintegrated Medina red sandstone and shales splendidly adapted for apple raising. These soils will produce vigorous disease resisting trees which yield large crops of well developed, highly colored, nicely flavored fruit. The place is not as accessible as it should be for fruit raising. The Hudson River shale formation is more extensive northeast of this upland section along the sides of Brush and Bald Eagle mountains with a larger area of farming land, not so steeply hilly, with deeper and equally as warm early spring farming soil with larger but still limited water and fertility holding capacity adapted for raising all the regular farm crops especially wheat and the legumes such as alfalfa red and alsike clovers among the perennials, and winter vetch, crimson clover, the Canada field pear and the soja bean. Peach and apple trees grow thriftily and produce large yields of very desirable fruit.

The soils of the limestone valley or Sinking Spring Valley in which several small streams disappear in the limestone caverns and emerge at Arch Springs are similar in capacity and adaptation to the soils of Morrison Cove previously discussed to which the reader is referred.

SYNDER TOWNSHIP

This township occupies the northern extremity of the county, with the Huntingdon county line for its eastern, the Center county line for its northern and the Cambria county line for its western boundary. In the northeastern part of the township, along and on top of the Allegheny Mountain, the country is mountainous, rocky and stony, with not farming land except probably on the terrace, of Mauch Chunk red shale, which is not as stony but usually not accessible. The Pocono, as indicated at the beginning of this discussion, made the ridge of the Allegheny Mountain facing east with no farming land. The Catskill red shales make the foothills of the Pocono Mountain with some soils available for farming and fruit raising but usually quite inaccessible.

The soils derived from the Catskill red shales on the less steeply hilly sections, which do not wash as readily, are among the best apple soils in this section. The Chemung shales come immediately beneath the Catskill and are shaly, with some sandy strata making steep slopes, where the sandy strata occur and more moderate slopes where the shaly strata prevail, much of this land is thin with very limited water and fertility holding capacity adapted, the thinner types, for raising such crops as rye, early oats and buckwheat and for soil improving, sweet clover which when started in these soils should yield crops both for roughage to be fed with oats, rye and buckwheat and for improving the land. By applying the manure directly to the soils as it is made and by raising sweet clover sods, it seems that in a short time or within a period of years this land could be made to produce paying returns of corn and wheat, as well as some of the other clovers. If this can not be done, the land would better be planted with forest. The soils of the rounded foothills of the Allegheny Mountains are derived from the Portage flags, are thin with limited water and fertility holding capacity which when the water supply is sufficient will produce fair yields of the regular farm crops but during dry seasons, crop yields will be very much curtailed and either such crops as can be well started in the fall of the year and ripened before the usual dry weather of July and August sets in, followed with crops that will endure dry weather such as kafir corn, buckwheat, the cowpea and sweet clover, should be raised.

It seems with such an arrangement of crops fed into animals, the manure applied with the growing crops, this land could be made to yield, with the markets ready to consume all that is produced throughout this section, inviting returns. The deeper soils of the higher elevations will produce fairly vigorous Baldwin apple trees that will yield fair crops of highly colored, well flavored fruit. Some of these soils will produce the small fruits of good quality, and wherever these

thrive, they can be made more profitable than any of the agricultural crops, or even more profitable than apples, and with the demand for this kind of fruit thoughout this and the surrounding country, the markets could not well be overstocked.

Beneath the Portage flags comes the Hamilton shales which, in the counties hereafter discussed, in which this formation occurs, it is referred to as shales and sandstone forming ridges, while in this county the whole of the formation, composed of the Upper or Genesee, the Middle or Hamilton and the Lower or Marcellus, is composed of soft, dark slate, with limy strata, which become limestone in Maryland, which, wherever these occur sufficiently close to the surface, deeper plowing or stirring of the subsoil with a subsoiler and thorough cultivation will do as well as an application of lime. This formation is a valley maker here, because the agencies of disintegration have proceeded unhindered by the usual sandstone strata and the valley of Little Bald Eagle Creek in this township has been carved out of this formation. This is comparatively narrow, but the soils are deep usually warm, loamy, early spring farming soils, with large water and fertility holding capacity especially adapted, the more limy, for raising the legumes, and among these, alfalfa, red and mammoth clovers among the long season types, and the crimson clover, the winter vetch among the fall sown annuals, and the canada field pea, soja bean and northern grown cowpea among the spring sown. The Upper Helderberg limestone curves in with the formation above referred to. The soils of the valley of the Juniata River, in the southwestern part of this township, are derived from the same formation, the soft Hamilton shales as those of the Little Bald Eagle Creek. This is the valley along which the P. R. R. has run its main line from the city of Tyrone to Altoona. The Lower Helderberg limestone, which here is 800 feet thick, crested, opposite Tyrone with the Oriskany sandstone, together with the Hamilton strata above referred to make the fertile soils of this valley which extends westward through the following townships—Antis, Logan, Allegheny, Juniata, Freedom and Greenfield.

ANTIS TOWNSHIP

This township lies south of Snyder township, with the Cambria county line for its western boundary. The soils of the township are derived from the same underlying strata as those of Snyder township and are similar in capacity and crop adaptation, except the Altoona or Tuckahoe Valley. This valley widens at Tipton, along the Penna. R. R. The land is moderately, some gently rolling, with soils, as previously indicated, derived from the soft, easily disintegrated Hamilton shales and the Lower Helderberg limestone (the Oriskany sandstone is very narrow and its influence on the soil limited). The

soils derived from the two previously named formations are stony loams gravely loams and the finer loamy types and are deep and moderately rolling, the stony and gravely and sandy loams are warm, early spring farming soils, with fair water and fertility holding capacity, the more limy types especially adapted for raising the legumes and cereal crops previously indicated. The uplands along the valley are adapted for raising small fruits and apples and the moderately rolling sections with deep, warm, early spring farming soils, in so far as possible, should be used for raising early market gardening crops, while the lower colder loams and clays should be used for raising the crops for feeding the dairy herd or other livestock.

LOGAN TOWNSHIP

This township lies south of Antis, along the Blair county line. Altoona, the largest city of the county and one of the greatest manufacturing centers in the State, is located in this township. This city is one of the best and largest markets of all agricultural and horticultural products in this State and will consume all the market gardening, dairy and fruit products that can, with present labor conditions, be produced in this county. As previously indicated, a large acreage of the more naturally limy soils are splendidly adapted for raising alfalfa as well as the other perennial and annual clovers. Corn, oats and wheat also yield large crops throughout this valley. With such an array of both cereal and leguminous crops, a rotation could readily be worked out by means of which the crops that are necessary for feeding a dairy herd could be largely produced on the farm and the producing capacity of the soil maintained or even increased. The origin of the soils of the township are similar to those of Logan township and therefore need no further discussion.

ALLEGHENY TOWNSHIP

This township lies south of Logan with the Cambria county line for its western boundary. Along the western border of the township the coal measure strata take part in the formation of the soil. The land is rolling, with deep, stony, shaly and sandy loams, with limited water and poor fertility holding capacity, and at such an elevation that the agricultural methods prevailing on the fertile soils of the valley are not suited for this section. A cropping system should be worked out for such crops both agricultural and horticultural as practical experience would demonstrate to be best adapted to yield inviting returns, and at the same time maintain and improve the fertility of the soil.

Logan township has a similar section of soils. The outcrop of the Catskill strata widens in this township and the soil area is somewhat wider, but the soils are similarly hilly, stony and inaccessible, except

in some limited areas. Otherwise the soils along the mountain are the same in origin and configuration as those previously discussed. The outcrop of the Lower Helderberg limestone widens in this township, but the soils are similar in adaptation and configuration, to those previously discussed.

JUNIATA TOWNSHIP

Juniata township lies southwest of Allegheny, along the Blair county line. The soils of the township are derived from the Pocono, the Catskill, the Chemung and Portage strata. The most extensive area of soils of agricultural and horticultural value occur on the Catskill red sandstone hills throughout the central and western part of this township.

The land is hilly, but not too hilly to be successfully farmed. The soils are stony loams, sufficiently deep, with such a water and fertility holding capacity as will produce and ripen a large crop of apples during a normal season. This is an area of the best apple soil in this section of the State, and should as much of it as is accessible be used for raising this fruit, and such a succession of soil improving crops should be worked out as experience will demonstrate will put these soils into the best condition to make a sufficiently vigorous, disease resisting wood growth each year as will set and develope large crops of highly colored, nicely flavored fruit. This has not been done up to this time but can be done. Along Blairs Gap Run and in the eastern part of the township the soils are similar to those of the same formation previously discussed.

FREEDOM TOWNSHIP

This township lies southeast of Juniata and west of Taylor. The soils of the township are derived from the Catskill, the Chemung, the Portage, the Hamilton and the Lower Helderberg limestone with similar capacities and adaptations to the townships previously discussed.

At East Freedom the soils of the gently rolling valley are derived from the soft Hamilton shales and are deep, with large water and fertility holding capacity, well adapted for raising the regular farm crops; but especially adapted for raising corn, the hay grasses and alsike clover, while the slightly higher elevations will produce alfalfa and red clover, and among the cereal grains, corn, wheat and oats. Strawberries and all the small fruits thrive well along and upon the rolling uplands. Apple trees make a fair growth, but do not grow as vigorously as on the soils derived from the Catskill strata further west.

GREENFIELD TOWNSHIP

This township occupies the southwestern corner of the county. The soils of the township are derived from the Pocono sandstone, the Catskill red shales, the Chemung shales, the Portage flags and the Hamilton group and the Lower Helderberg limestone. In the northern part of this township several rolling upland sections occur with less stony and deep loamy soils similar to those of Juniata township, which it seems should be, because of location and formation among the best apple soils anywhere throughout this part of the State and where accessible, should be planted with trees. In the southeastern corner of the township of Helderberg limestone formation widens and makes a larger area of limestone soils, otherwise the eastern part of the township is similar to Freedom township.

BLAIR TOWNSHIP

Blair township lies south of Allegheny, east and north of Freedom and west of Taylor. The soils of the township are derived from the Hamilton shales, the Lower Helderberg limestone and the Clinton shales. The limestone formation spreads out in a triangular form where it changes its southern to a northeastern course and makes a hilly, but fertile section, with deep, loamy and clayey soils, with large water and fertility holding capacity, adapted for raising all the agricultural crops indicated for the loamy and clayey soils of Morrison's Cove. The Clinton shales make a section of soils in this township, the capacities of which will be discussed in connection with Frankstown township. The Hamilton soils, or those derived from this formation, are similar to those previously discussed. The following analysis of three specimens of limestone gotten from quarries of the Lower Helderberg limestone, near Hollidaysburg, the county-seat of this county, which is located in this township, gives an idea of the purity and fitness of this stone for agricultural as well as for all other purposes for which lime is used.

Analysis.—

Carbonate of lime, ...	95.251	96.164	84.782
Carbonate of magnesia, ...	2.265	1.589	3.859
Carbonate of iron, ...	0.745	0.615	0.534
Alumina, ...	0.054	0.033	0.043
Sulphur, ...	0.053	0.070	0.053
Phosphorus, ...	.003	0.005	0.004
Insoluble residue, ...	1.800	1.615	10.850

FRANKSTOWN TOWNSHIP

This township lies east of Allegheny and Blair, north of Taylor, west of Huston and Woodbury. The soils of the township are derived from the Chemung shales, which cover the central upland of Scotch

Valley or Frankstown Cove, the Portage flags, which make the hilly country beneath the Chemungs and the Hamilton group which, together with the Helderberg limestone and the Clinton shale, makes the more moderately rolling land around the Cove. The Lower Helderberg limestone formation, after changing its course in Blair township, extends northeastward through Frankstown township to the Beaver dams in Scotch Valley Cove. From here it turns south along the foot of Canoe and Lock Mountains to Old Town Run, where it broadens and changes its course northeastward to Frankstown, whence it comes west and south around the foot of Dunning's Mountain which it follows southward into Bedford county. It is evident from this that this township contains a more extensive outcrop of Lower Helderberg limestone than any township of this county. The limestone belt extending from Blair township northeastward, together with the soft Hamilton and the Clinton shales, make an area of fertile limy soils, while along the foot of Canoe and Lock Mountains the valley is more narrow, with more stony and rougher soils, with little or no beneficial effects from the limestone.

Along the southern outcrop, the limestone formations is equally as wide as the northeastern outcrop, with soils equally as fertile, derived from the same underlying strata. The Clinton shales formation which parallels the Altoona valley and spreads over the area between the Lower Helderberg outcrop along the Altoona Valley and that along Frankstown Cove, makes the most extensive outcrop of this formation in this county. The land is hilly. The soils are usually fairly deep with large fertility holding capacity, but rather limited water holding capacity. The deeper loamy well drained types are warm and fall sown early summer ripening crops can make an early start and spring sown crops can usually be sown early but not as early as the same type of soils derived from the Hudson River shales. The rougher stony loams derived from this formation will produce vigorous peach trees that will yield large crops of well developed, highly colored and nicely flavored fruit. These soils will produce a splendid quality of wheat. The legumes, such as alfalfa and red clover, will yield splendid crops on the more limy, deep rolling land along the hills, while alsike clover and timothy will yield better crops in the lower areas. Small fruits will yield better returns, with less labor, than any of these crops in these soils. With the markets to consume all that can be produced, it behooves the farmer to produce all that the soils will make it possible to produce.

HUNTINGDON COUNTY

Huntingdon county was erected from Bedford by an Act of Assembly, passed September 20, 1787. It contains 587,520 acres of which 340,539 is land in farms, and of which 188,897 acres is improved farm land. 24,126 were planted in corn in 1909, yielding 602,961 bushels; 13,904 acres were sown with oats, yielding 293,148 bushels; 21,520 acres were sown with wheat, yielding 273,868 bushels; 3,118 acres were sown with buckwheat, yielding 35,749 bushels; 3,710 acres were sown with rye, yielding 34,920 bushels; 2,253 acres were planted with potatoes, yielding 175,316 bushels; 30,128 acres were sown with all forage crops, yielding 33,209 tons of various kinds of hay. Of the 188,897 acres of improved farm land, 98,759 were used for raising farm crops while 90,138 were not so used and were likely producing weeds. At this time Huntingdon county had a population of 38,304 to feed, 19,224 cattle, 6,149 horses, 745 mules, 13,543 swine and 14,505 sheep.

The county is bounded on the north by Centre, on the east by Mifflin, Juniata and Franklin, on the south by Fulton and Bedford and on the west by Bedford and Blair. The outcropping rock strata from which the soils of this county are derived, range from the coal measures on Broad Top Mountain down through the Pottsville conglomerate, the Mauch Chunk red shale, the Pocono sandstone, the Catskill sand and shale, the Chemung, Portage, Genesse, Hamilton and Marcellus, the Oriskany sandstone, the Lower Helderberg limestone, the Onondagua and Clinton shale, the Medina and Oneida sandstone, the Hudson River and Utica shale and the Trenton limestone.

The drainage of the county is accomplished by the Juniata River and its branches. Beginning with Dublin township, in the south east corner of the county, the straight Tuscorora Valley comes in from Burnt Cabins, Fulton county, and extends through Tell township or the entire S. E. length of the county. The Tuscorora Mountain forms the eastern boundary of this valley, which is formed of Oneida and Medina sands, with its side of Clinton shale, with lower ridges of Lewistown limestone and Oriskany sand, with numerous elevations of Hamilton and Chemung shales through the center of the valley and with similar ridges of Oriskany sand and Lewistown lime on the western side of the valley, with the lower sides of the mountain crowned with Medina and Oneida sand, forms the Shade Mountain coming in from Fulton county. This valley contains a considerable acreage of soils made up of the formations above stated, well adapted for agricultural plants, especially where the Clinton shales, Lewistown lime and Oriskany sand intermix to form the mineral basis of the soils, or where the Hamilton shales and the Oriskany sand and the limestone mix as they do at such places as Shade Gap.

Apple trees make a luxuriant growth in these soils, and wherever the markets are available the stony and larger gravelly sections of these soils should be used for fruit.

A branch of the E. B. T. R. R. enters the valley at Shade Gap. Shade Mountain forms the eastern boundary of Black Log Valley, in which occurs or comes up the Utica shales No. 3 and the Trenton limestone No. 2. This valley has some fertile agricultural land and some good farming is done. An extensive limestone quarry was opened facing the Gap, made by the Black Log Creek, opposite Orbisonia. Here lime of more than ordinary purity could be burned cheaply, in flame kilns, with the coal of the Broad Top region and applied on the shale and gravelly limestone soils, with the best results, as experience has shown to be the case. Black Log Mountain in Springfield, Cromwell, and Shirley townships, forms the western boundary of Black Log Valley. The eastern side of this mountain is formed of Utica shale, Medina and Oneida sand and the western, of these sands and the Clinton shale with the lower hills and valleys of Lewistone lime and Oriskany sand.

This Clinton shale, Lewistown lime and Oriskany sand formation comes in from Fulton county, south of Fort Littleton and makes a fertile, rather narrow valley, extending through the three townships, already mentioned, into Mifflin county. At Germany Valley and Shirleysburg, it widens and very much enlarges the soil area some of which is low and spouty, but could easily be drained. In its present condition it is well adapted to growing the hay grasses, while drainage would adapt it to more exacting crops. West of Germany Valley and coming in from Fulton county, is quite an extensive undulating valley of Chemung, Hamilton and Marcellus shales, drained by the Aughwick Creek and extending into Mifflin county. This is not as rich a soil as the limestone east and west of it, but with good farming can be made to produce, especially when there is a normal amount of rainfall, but with dry weather, these soils will not yield paying crops; therefore, crops that will endure dry weather, such as buckwheat, cowpeas and rye should be raised. West of this Chemung soil formation are two parallel Clinton shale and Lewistown limestone valleys, the eastern, called Aughwick and the western Hares, separated by Shade Mountain, which begins in Clay township, south of Saltilo, and extends into Mifflin county, which are similar, in soil of formation, to those already described in the eastern part of the county. West of this comes the Broad Top region in Carbon, Todd, Cass and Union townships, of which Sideling Hill forms the eastern boundary. The eastern slope of Sideling Hill is composed of Oriskany sand, Chemung shales, and Catskill sand with a top of Pocono sand. There is very little farming land in this region, on these formations, until the

Mauch Chunk red shale valley drained by the Little and Great Trough creeks, which empties into the Raystown Branch of the Juniata is reached. This branch follows a very tortuous course on the Catskill and Mauch Chunk formation and flows into the Juniata, south of Huntingdon. The Trough Creek Valley has in it, especially toward the lower end, where the valley is wider, some good agricultural land. The valley as a whole is approximiately 200 ft., higher than all the surrounding farming land and, in consequence, crops ripen a little later than on the less elevated sections of the county.

A grey limestone occurs half a mile west of Calvin, a small town in the valley that makes very desirable agricultural lime and with coal only a few miles away, can be burned cheaply. This limestone runs along with the Mauch Chunk red shale and the Pocona sand. Terrace Mountain, a Pocona sand formation, forms the western border if this valley, which joins Sideling Hill opposite Huntingdon and rises in a spur 2,000 ft. above tide. The coal shale formation on top of Broad Top Mountain makes a soil well adapted for agricultural crops, especially rye, oats, buckwheat and timothy. Apple trees grow luxuriantly on this soil and peaches do very well, on the southeastern slopes. As already stated, Terrace Hill forms the western border of this valley. It slopes gently eastward and makes agricultural soils in some sections that are well adapted for fruit, especially peaches, which were raised here more than twenty-five years ago. Hopewell, Lincoln, Penn, Juniata, Walker and Porter townships lie on the western border of the county and are traversed by the Catskill formation, upon which flows the Raystown Branch of the Juniata, in her tortuous course to the Juniata. The Chemung shales, with their hilly formation and the Oriskany sand and the Lewistown limestone, with rolling soil formations and occasional precipitous spurts making a fertile soil adapted to all agricultural plants raised in this section prevail. West of this, the Clinton shales sloping up to Tussey Mountain, which forms the western boundary of the county makes fertile soil. This limestone valley widens as it approaches the Juniata River, and at Huntingdon Reformatory, makes a beautiful valley of soils adapted to the raising of all kinds of agricultural and garden crops. Here the Marcellus limy shales also enter the formation of the soil, the effects of which are very evident, in crop yields.

BRADY TOWNSHIP

Brady township lies north of the Juniata River, at Mount Union, along the Mifflin county line. The outcropping strata extend from the Genesee formation down into the Trenton limestone of Kishicoquillas Valley. At Mount Union, along the river, is a valley with some fertile alluvial soil well adapted for raising all agricultural crops.

Jack's Mountain, with its crest of Medina and Oneida sandstone, is gapped by the river just west of the town. This mountain makes a rough country, with only a narrow strip of agricultural soil on both the east and west sides of the ridges formed by the Clinton shale and Lower Helderberg limestone. The Oriskany sandstone makes a ridge farther northward. Jack's Mountain divides into Jack's and Standing Mountains and enclose Kishicoquillas Valley, which extends from this point northeastward through Mifflin county, making one of the most fertile valleys of the State.

HENDERSON TOWNSHIP

Henderson township lies west of Brady, along the north side of the Juniata River. The outcropping rock strata which form the basis of the soil extend from the Catskill sandstones and shales down into the Clinton shales. The Catskill formation is a continuation of Terrace Mountain, in the central part of the township, upon which the Raystown Branch of the Juniata River and Smith's Run flow northward; while upon the Chemung Valley, Little Trough Creek flows southward, both valleys containing farming soils. Little Ridge forms the eastern boundary of the township, along the union of the Catskill and Chemung strata. The Catskill here, as is usual, is more rolling than the Chemung and forms a richer soil, especially where the red strata of this formation outcrop. Stone Ridge, forms the western boundary of the township and is a continuation of Piney Ridge on the south side of the river formed of the hard Chemung strata, while the valleys are formed of the Hamilton strata, which are more easily disintegrated. These soils are, however, not fertile, as fertility is regarded on the limestone soils of this county.

ONEIDA TOWNSHIP

Oneida township lies west of Henderson, with the Juniata River for its southern boundary. The strata from which its soils are derived, include the Genesee, Hamilton and Marcellus, with Stone Ridge formed of the Portage which makes the high cliffs of sandstone, along the railroad below Huntingdon. The high hill back of the town is formed of the Hamilton beds while the valleys along the streams are formed of the Marcellus shales, as is the case west of Huntingdon. Among the lower strata of these Marcellus shales, several limy shale formations occur and enter the structure of the soil. The valley along Standing Stone Creek is formed on the soft Hamliton and Marcellus, easily disintegrated rock, while the high ridge of Portage, with a precipitous northwest slope, forms the eastern township line, until Murray's Run is reached, when

it makes the township line and Stone Ridge makes a ridge between it and Standing Stone Creek with poorer soils. The Marcellus strata usually make a fertile soil, which is the case throughout this township. Warriors Ridge, formed of Oriskany sandstone, makes the western boundary of the township, with a little Lower Helderberg limestone outcropping in the northwestern corner. The soil of the Hamilton and Marcellus formations here are fertile and will produce all agricultural crops that thrive in this part of the State.

Huntingdon, the county-seat of Huntingdon county, is located in this township.

LOGAN AND WEST TOWNSHIPS

Logan and West townships lie west of Oneida, along the Juniata River. Warriors Ridge forms the eastern boundary and Tussey Mountain the western. The strata from which the soils are formed, range from the Lower Helderberg limestone, along Warriors Ridge, down to the Medina and Oneida sandstones on Tussey Mountain. As already indicated, Warriors Ridge forms the eastern boundary, which is elevated gradually until the Lower Helderberg limestone comes to the surface. In the northern part of the township, swinging in a curve round to Petersburg, bordering the Salina limestones and shales, which form the base of the valley and the soil along Shaver's Creek, which, because of these more easily disintegrated strata, makes a broader and more fertile valley, than is usual in this county. Westward from the valley the harder Salina shales form a low ridge, while the fossil ore outcrops form still another and more prominent ridge. These fossil ore outcrops, together with the Clinton shales make some desirable fruit soils in this section, especially adapted for peaches. West of the fossil ore outcrops, the land becomes too steep for any thing but forest land.

PORTER TOWNSHIP

This township lies south of Logan and north of Walker along the south side of the Juniata River. It contains the same outcropping rock strata, as those of Logan and West township, and has Tussey Mountain for its western boundary. Warriors Ridge reaches its greatest height in this township, rising to 1,250 feet above tide. The Hartslog Valley, inclosed between the Little Mountain and the Frankstown Branch of the Juniata, has a soil formed of drift materials different from the soils formed of disintegrated rock in Situ; otherwise, the soils are similar, except that it seems the soils of Porter are more fertile than those to the north of the river.

BARREE AND MILLER TOWNSHIPS

Barree and Miller townships lie northeast of Henderson, Oneida, Logan, and West townships, and extends from Standing Stone Mountain, on the southeast to Tussey Mountain on the northwest. Warriors Ridge, accompanied with the Lower Helderberg limestones swings in a sort of a semicircle around the head of Huntingdon Valley and becomes Sand Ridge in the southeastern part of the township. The accompaning limestone is very narrow in the southeastern part of the township and does not amount to much in the structure of the soil. Northwest of Sand Ridge, the Marcellus, Hamilton and Genesee, with probably a little Chemung, are the basis of the soil, and while the country is hilly, the soil, where the Chemungs do not enter the structure, is fairly fertile, especially where the limy shales appear.

North of this triangular structure of the head of the Huntingdon Valley, Warriors Ridge crosses the township in a northeastern course to the Jackson township line. Northwest of this Oriskany Ridge is a broad outcropping of Lower Helderberg limestone, and the Salinas which, at such places as Manor Hill sweeps around with the projections of the fossil ore outcrops, form the agricultural soil of this township. Further northwest the county becomes hilly and is difficult to farm.

JACKSON TOWNSHIP

Jackson township occupies the northeastern corner of the county, with Mifflin county for its southeastern and Centre county for its northern and western boundary. The strata from which the soils of this township are formed range from the Lower Helderberg limestone, through the Salinas, the Clinton shale down to the Medina and Oneida sandstone. In the southeastern part of the township, along the east branch of Standing Stone Creek and northwestward beyond the main branch of Standing Stone Creek, is a triangular section of Lower Helderberg limestone and the lower and upper Salinas which make a fertile soil. Throughout this part of the township, extending northwestward beyond McAlveys Fort and to some extent along the streams, beyond this, the Clinton shales and the fossil ores, wherever the formation is not too steep and disintegration has proceeded to such an extent that the soils are loamy, make unsually fertile soils easily farmed and well adapted for raising the cereal grains. The same type of fruits soils already referred to in other townships occur here with a larger acreage.

MORRIS TOWNSHIP

Morris township lies south of the Juniata River and west of Porter township. The strata from which the soils are derived, range from the Clinton shale on Canoe Mountain down into the Trenton limestone

in Canoe Valley. It has Tussey Mountain for its eastern and Canoe Mountain for its western, the Little Juniata for its northern and Fox Run for its southern boundaries. The farming land of this township is confined to Canoe Valley and the narrow strips of Hudson River shales running along the sides of the valley immediately below the Medina and Oneida sandstone, which forms the crest of the surrounding ridges. That this country is hilly and even mountainous is shown by the elevations above tide, that of the crest of Canoe Mountain being 2,200 feet, the terrace along the mountain 1,640 feet, a limestone knoll in the valley 1,060 feet. and the mouth of Fox run 800 feet.

This does not mean that there is little or no farming land in this valley, but rather that there are here differences in elevations greater than anywhere in the agricultural sections of the State. The formations of the soil differs at each elevation. Beginning with the Clinton shale soils, in the depression, in the crest of Canoe Mountain 2,150 feet above tide, followed by the soil on the mountain terrace formed of the more easily disintegrated Oneida red sandstone and shale 1,640 feet above tide and by the soil on the limestone up bulging 1,060 feet above tide and by that of the valley at the mouth of Fox run 800 feet above tide, all of these changes in altitude occurring within a distance of four miles, in soils that can be farmed. Similar conditions occur in a number of places in this county. Here is a possibility of asking nature the question, in her own realm, with what crops can you furnish the largest amount of human nutrition, at these varied altitudes, with the soils as they exist.

FRANKLIN TOWNSHIP

This township lies west of West and Barree, west of Tussey Mountain with the crest of Tussey Mountain for its eastern boundary, the Centre county line for its northern and the Little Juniata for its southern boundaries, and occupies about one-half the territory of Nittany Valley or that part of it known as Spruce Creek Valley in Huntingdon county. The outcropping strata which forms the basis of the soils, range from the Medina and Oneida sandstones down into the Silurio Cambrian or Trenton limestone which covers this entire valley.

Spruce Creek flows in a southeastwardly course through the entire township pretty close to the long, gentle slope, from the Utica black slate to Spruce Creek. Tadpole Ridge, ranging from 200 to 300 feet in height, runs along the northwest side of the creek with Tussey Mountain on the southeast makes a hilly, but at the same time fertile country. The soil on these hills, on the southeast, are derived from the disintegrated strata of Utica shales and limestone, while those on

the northwest are formed of a disintegrated sandy limestone. These soils will produce all agricultural crops; but it seems are especially adapted for wheat, clover, potatoes, corn and oats. It seems, with a rotation of wheat, clover and potatoes or of clover corn and oats, an agricultural operation could be made to yield good returns, if all the crops, except the potatoes, would be turned into milk, beef or pork.

Cale Hollow lies between Tadpole and Gatesburg ridges. Several divides makes this hollow an undulating valley of fertile land, with similar adaptations to the soil already referred to. Along the whole course of this stream the land is hilly, but all the hills are underlaid with limestone, and where disintegration has proceeded only sufficiently deep to make any thing like a soil, which if made of other than limestone rock would not grow any thing, will produce splendid crops on these limestone. These soils are stony, gravelly, loamy and sometimes clayey. Cale Hollow is largely confined to the section northeast of Warriors Mark Run which flows into this township from Warriors Mark township. The part of this township southeast of this stream is largely a rolling plateau of the same type of soils already described.

WARRIORS MARK TOWNSHIP

Warriors Mark township lies west of Franklin and occupies the western half of Nittany Valley, with the Centre county line for its northern, the Blair county line for its western and the little Juniata River for its southern boundaries. The lines do not run parallel with the points of the compass. The outcropping strata are the same as those of Franklin township. The drainage of this township is largely carried away underground, through large and intersecting caverns. Dry Hollow, broad and shallow, comes in from Centre county and extends to Warriors Mark Run, where it merges with Cale Hollow and whence it resumes its course to the Juniata River. Dry Hollow Ridge northeast of Dry Hollow, also begins at the Centre county line, with a summit of 1,300 feet, extends to Warriors Mark Run, where it makes a steep decent to the run 1,260 feet above tide, from whence it also resumes its course to the Juniata River, ending in a summit of 1,300 feet above tide with a deep ravine and several additional summits. The fact that this country is largely drained by underground water courses does not injure its agricultural capacity, in fact it seems to benefit it. As large and even larger crops are raised than in other parts of the valley.

At Warriors Mark is a beautiful rolling country of splendid fertility easily farmed, and when treated at all with agricultural decency, very productive. This is one of the intensive farming sections of the State with soils of such fertility, as will permit the exportation of

such agricultural crops as will take away from the soil a certain amount of fertilizing elements without, with the right kind of agricultural practice, permanent injury to the soil. The Bald Eagle Mountain forms the western boundary of this township and of the county, with steep slopes until the Utica shale is reached when the slopes become more moderate. The soils where formed of the intermixture of the shales and limestone are adapted for grain farming, are easily farmed and when well treated productive. The elevations above tide range from 597 feet at Mount Union to 2,054 at Broad Top City. In the best agricultural sections the elevations range from 1,000 to 1,200 or 1,300 feet.

This county contains some of the most fertile soils of the State adapted to the most intensive farming.

CENTRE COUNTY

The act for creating parts of the counties of Mifflin, Northumberland, Lycoming and Huntingdon into a separate county, to be called Centre, was approved February 19, 1800. It contains 733,440 acres, of which 286,822 acres is land in farms, and of which 188,033 acres is improved farm land. 27,085 acres were planted in corn in 1909, yielding 663,893 bushels; 20,791 acres were sown in oats, yielding 518,229 bushels; 30,751 acres with wheat, yielding 518,229 bushels; 1,656 with buckwheat, yielding 20,666 bushels; 1,914 with rye, yielding 19,693 bushels; 2,869 acres were planted with potatoes, yielding 251,062 bushels; 43,135 acres were sown with all forage crops, yielding 46,230 tons of various kinds of hay. Of the 188,033 acres of improved farm land, 128, 201 were used for raising farm crops while 59,832 were not so used and were likely producing weeds. At this time Centre county had a population of 43,424 people to feed, 23,208 cattle, 8,217 horses, 229 mules, 17,914 swine and 11,789 sheep.

This county occupies the centre of the State and gets its name from this fact. It lies north of Union, Mifflin and Blair counties, east of Clearfield, south of Clearfield and Clinton and west of Clinton. The geological formations from which its soils are derived begin with the Lower Silurian limestone, which attains a thickness in this county of 6,000 feet, followed by the Utica and Hudson River slates, the Oneida sandstone, the Medina red and white sandstone, the Clinton red shale and iron ore, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus, Hamilton, Genesee, Portage and Chemung shales, the Red Catskill, the Pocono sandstone, the Mauch Chunk red shale, the conglomerate, into the coal measures, an enormous series of deposits similar to Perry county.

The drainage of the county is accomplished by the streams flowing eastward into the Susquehanna River at Lock Haven, except the southern part, including Potter, Gregg, Miles, Penn and Haines townships, which are drained by tributaries of Penn Creek, flowing south east; while the southwestern townships, Taylor, Half Moon and Ferguson are drained into the Juniata by the little Bald Eagle Creek and branches of Spruce Creek.

The streams which flow principally eastward into the Susquehanna are the Mashannon, which forms the greater part of the western boundary between Centre and Clinton counties for the last eight or ten miles until it flows into Bald Eagle Creek. Bald Eagle Creek rises in Taylor township and flows eastward through the Bald Eagle Valley and empties into the Susquehanna River below Lock Haven, being, together with its tributaries, the most prominent stream of the county.

RUSH TOWNSHIP

This township occupies the western extremity of the county, with the Blair county line for its southern, the Clearfield county line for its western boundary. The soils of the township are derived from the conglomerate and the strata of the coal measures. The crest of the Allegheny Mountains is formed of the conglomerate sandstone in which summits occur varying in height above sea level from 1,500 to 2,300 feet. The soil is sandy on the surface and stony underneath, derived from a poor soil making rock, with small water and fertility holding capacity adapted for timber, making small demands for fertility and capable of enduring adverse conditions.

Below the crest of the mountain the land is more rolling, but the soils are derived from the same materials, and while more easily cultivated, they do not return inviting yield of any of the regular farm or fruit crops, and the best use that could be made of the whole southwestern section of this township, would be to convert it into timber land under the management of the State so as to prevent forest fires.

In smaller areas along and at some distance away from the streams at such places as where Mountain Branch flows into the Mashannon, are moderately rolling sections, with deep warm soils derived from the coal shales, entirely different in character from those derived from the conglomeratic rock, adapted for raising such of the regular farm crops as oats, timothy and clover hay, and also adapted for raising potatoes, truck crops and small fruits. Peaches are said to thrive fairly well, producing vigorous trees which make such a growth annually as will enable them to produce fairly large crops of well developed fruit.

These soils, as already intimated, are well adapted for raising the hay grasses, especially timothy and the red and alsike clovers and with lime, also alfalfa in the higher and more rolling sections.

It seems with such crop adaptations it should be possible to arrange a rotation in which the Canada field pea and oats could be made to produce a combined hay and grain ration which, in connection with corn silage, and by purchasing some corn and concentrated feeding stuff, dairying or livestock raising could be made both a paying and soil improving proposition especially with the markets in the immediate vicinity to consume all that can be produced. These soils, beside occurring on the higher sections along the river, occur at Powelton, Jimtown, Edenvale, Boynton, South Phillipsburg and Phillipsburg.

SNOW TOWNSHIP

The township lies northeast of Rush, largely on the Allegheny Plateau. The soils of the southern and western part of the township are derived from the conglomerate and the sand rock and are similar to the soils of the same derivation as those of Rush township. On the upland along Little Mashannon and in the vicinity of Snow Shoe, northward along the northern border of the township where the coal shales and sandstone make the basis of the soils, they are similar in capacity and adaptation to the soils of similar derivation discussed the Rush township and therefore no further discussion is necessary here.

BURNSIDE TOWNSHIP

This township occupies the northern limits of this county and has the West Branch of the Susquehanna River for its western and northern boundary, the Clinton county line for its eastern, and Snow Shoe township for its southern. The soils of the township are derived from the same underlying rock as those of Snow Shoe.

In this township the soils, derived from the coal shales and sandstone, are located in the southern and western part of the township, a characteristic section of which occurs at Germania along the southern border of the township where several limy formations occur which make the soils more fertile, the effects of which are shown in the timber growing in this vicinity. From Germania northward to where the river changes its course, from an approximately northwestern to a northeastern course, is quite an extensive section of moderately rolling land with comparatively deep warm soils, with fairly large water and fertility holding capacity derived from the coal shales and sandstone adapted for raising hay. Among the corn in fields when not cultivated, instead of producing weeds, timothy will begin to grow and a timothy sod can be frequently started in corn fields without seeding. From Germania eastward the soils are derived

from the same formation, but the land is more hilly and rough especially along the streams which rise on the plateau which extends through the central part of the township and makes the divide between Beech Creek on the south and the Susquehanna River on the north. The farming land of this township is confined to these sections.

CURTIN TOWNSHIP

This township lies east of Burnside, Snow Shoe and Boggs townships, with the Clinton county line for its northern and eastern boundaries. The soils of the township are derived from the same geological formations as those of the previously discussed townships, except that in the southern part of the township, south of the Pocono terrace, the soils are derived from the Catskill red shale, which will be discussed later. The farming soil of the township are located on the uplands on both sides of Eddy Lick Run and are of similar derivation and character as those previously discussed. The townships through which the Bald Eagle Valley extends from Blair county on the west to Clinton county on the east, have soils derived from strata ranging from the Medina sandstone No. 4 on Bald Eagle Mountain to the Pocono No. 10 on the Allegheny Mountain.

The following townships, beginning with the Blair county line, contain the formations above referred to: Taylor, Worth, Huston, Union, Boggs, Howard and Liberty.

TAYLOR TOWNSHIP

Taylor township lies south of Rush township, with the Blair county line and the Bald Eagle Mountain for its southwestern and southern and the Allegheny Mountain for its northern boundaries. The soils of the township along the northern flank of the Bald Eagle Mountain are derived largely from the debris of the White Medina sandstone which has largely covered up the Clinton strata which would otherwise crop out and take a more prominent part in the formation of the surface soil. The soils of the valley are derived from a mixture of the Lower Helderberg limestone, the Marcellus and Hamilton formations which extend to the southern slope of the Allegheny Mountain, interspersed with rounded slate hills, with soils derived from the less easily disintegrated Hamilton strata. The Portage and Chemung formation make a more steeply hilly country, with low terraces wherever the harder of these strata outcrop, while the Catskill formation, still higher up makes the most fertile soils of the county except those derived from the limestone, the limy shales and easily disintegrated shales of the valley.

The soils along the northern slope of Bald Eagle Mountain, as previously indicated, are derived from the debris from the mountain and the Clinton formation which, because it yields more readily to

disintegrating agencies, makes these soils, in the more moderately sloping sections which are more prevalent in this township, because the divide from which Bald Eagle Creek flows eastward is located just outside of this township and the valley is comparatively high and, therefore, the slopes of the hills not as steep and the soils deeper because less readily eroded, having large water and fertility holding capacity. It seems that the stony land of the more moderately rolling sections, with these deeper soils, should be well adapted for fruit raising especially apples, after a system of raising, such soil improving crops for mulching as will maintain the fertility of the land and produce and ripen such a wood growth as will annually yield remunerative crops of well developed and nicely colored and flavored fruit.

Some of the less steeply hilly sections are farmed and the regular farm crops are raised, and where hillside farming is practiced so as to prevent washing, remunerative crops of corn, oats, wheat and the hay grasses are produced. The area of wheat is not large, but it seems from indications this could be made one of the crops in a rotation along these hills that could be made to yield large crops. These are deep, warm, early spring farming soils in which early or late sown fall crops will make an early start or which can be cultivated and sown with such crops as oats and Canada field peas before the soils in the valley are dry enough to begin farming operations, and on a farm, therefore, which is made up of hillside and valley land the rotation can be arranged in such a way that the late fall sown, early summer ripening, cool weather crops or the cool weather early spring sown, mid-summer ripening crops can be raised while the late spring planted or sown, hot weather fall ripening crops can be raised on the valley land. The soils in the valley are clayey and in places wet and cold needing underdrainage which, when underdrained, makes the best agricultural land of the township.

On the northern side of the valley where the soils, as previously indicated, are derived from the Hamilton shales and sandstone, the Genesee and Portage along the lower slopes are fairly deep but not as fertile as similar localities on the northern slope or Bald Eagle Mountain, and will not produce as large yields of the same type of crops as will those soils. On the higher slopes and on the rounded hills along the valley, the soils derived from these same strata are thinner and are known as gravelly land with limited water and fertility holding capacity in which crop yields are curtailed by only short droughts and frequently crops from these soils are such, when rainfall is limited as to make farming a most uninviting operation.

If it is deemed necessary to farm these soils, then such crops should be raised as will make their main growth during the months of the largest rainfall, and after this season such drought enduring soil im-

proving crops as sweet and Mammoth clover sown with the moist weather plants, should be grown so that a money and a soil improving crop might be produced. The land with soils derived from the Chemung shales and sandstone is still more hilly and is largely covered with cut over timber some of the less steeply hilly sections are farmed and yield larger returns of the regular farm crops than the soils previously discussed. A rotation of crops embracing rye, winter vetch, buckwheat, mammoth and red clover, the clover followed with corn and the corn with rye and vetch and these with oats, could be arranged so as to make returns while at the same time the land could be improved. North of the area of soils derived from the Chemung at an elevation in some places of 1,500 feet above tide the soils are derived from the Catskill red shales and sandstone. The land is stony, hilly and many places rough, but the soils are deep, with fairly large water and fertility holding capacity, adapted for raising such of the regular farm crops as will thrive under prevailing climatic conditions. Wheat, oats and corn yield fairly large crops. Timothy and red clover thrive especially well here and probably make among the best crop combinations both for financial returns and for soil improvement that can be produced here. The Canada field pea and oats should make an equally desirable combination while in the deeper and loamy types alfalfa should thrive. Potatoes yield large returns and a rotation of clover, potatoes and wheat or potatoes, followed with rye and winter vetch and these with oats and Canada field peas, and these with clover and the clover with potatoes would make a combination by which both potatoes and livestock could be made money crops.

But the crops for the raising of which these soils are especially adapted are apples, of which they will produce vigorous disease resisting trees that will yield large crops of well developed, highly colored, nicely flavored fruit. After a system of raising such soil improving crops has been worked out, as experience will demonstrate, to be best suited for mulching and enriching the soils so that it will continue to produce and ripen such a wood growth as will annually yield these superior crops of fruit and make apple raising a permanent industry.

WORTH TOWNSHIP

This township lies east of Taylor and south of Rush, with the Bald Eagle Mountain for its southern boundary. The soils of the township are derived from the same geological formations as those of Taylor township and are very similar in capacity and adaptation. The Bald Eagle Valley narrows in this township and the slopes of Bald Eagle Mountain are steeper with limited areas of soil of agricultural value.

HUSTON TOWNSHIP

Huston township lies east of Worth and south of Rush, with Bald Eagle Mountain for its southern boundary. The soils of the township are derived from the same geological strata as those of Taylor township, previously discussed, with similar capacities and adaptations and, therefore, no further discussion is necessary here.

UNION TOWNSHIP

This township lies east of Huston and south of Snow Shoe, with the northern slope of the Bald Eagle Mountain for its southern boundary. These soils of the township are derived from the same geological strata as those of Taylor township, except that the Catskill widens considerably in the eastern part of the township and the northern boundary extends for a considerable distance in to the conglomerate on the Allegheny Plateau. The Lower Helderberg limestone has been quarried at Unionville and lime burned from it. It is shaly and does not produce a very pure lime but still is sufficiently pure for agricultural purposes. At Unionville is probably the oldest extensive apple orchard in this county or at any rate in this section. It is planted on the northern slope of the Bald Eagle Mountain, in the valley and on the southern slope of the Hamilton and likely Chemung formation. The trees at this time are not sufficiently vigorous to produce large crops of highly colored, nicely flavored fruit all of which is likely due to soil conditions, and may be due to other causes; but whatever may be the reason, these soils derived largely from the Clinton shales, the easily disintegrated Marcellus and Hamilton which, is the case here, are not so well adapted to fruit raising as the Catskill, and the soils derived from the mountain debris and the covered up Clinton shale referred to in Taylor township.

BOGGS TOWNSHIP

This township lies east of Union and south of Snow Shoe, with the Bald Eagle Mountain for its southern boundary. The soils of the township are derived from the same geological strata, except that the Oriskany sandstone extends through the township within a few miles of the eastern boundary and takes part in the formation of the soil.

The valley along Bald Eagle Creek is wider in this township with clayey soils, inclined to be wet, adapted for raising the hay grasses; but also adapted for raising wheat and corn, of which, when cut up by deep tillage machinery or when underdrained, it will produce large yields of good quality. The Lower Helderberg limestone also crops out in this township. The Catskill soil continues through the township, retaining the width it attained in Union township with soils

of similar derivation and adaptation as those previously discussed, except along Marsh Creek where some meadow land occurs which will produce splendid crops of hay and the more sandy loamy types, potatoes, corn and wheat.

HOWARD TOWNSHIP

Howard township lies east of Boggs and south of Curtin, with the Bald Eagle Mountain for its southern boundary. The soils of the township are derived from the Clinton red shale, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus shales, the Hamilton, Genesee, Portage and Chemung shales. The Lower Helderberg limestone makes the valley throughout this township and broadens as it extends eastward. The land of the valley is fertile and adapted for raising all the regular farm crops such as wheat, corn and oats, among the cereal grains, and red alsike and Mammoth clovers, alfalfa, among the long season legumes, and among the short season fall sown, the crimson clover, winter vetch, and among the spring sown, Canada field peas and the warm weather clovers, the soja bean and the northern grown cowpea.

With an array of crops like these, it is possible to arrange a rotation by means of which a large amount of human food can be produced and the fertility of the land maintained and even increased. The Oriskany sandstone makes, in most places, a flattened ridge through this township on the northern slope of which the Marcellus black slate, containing limy strata, makes soils on the well rounded hills which, wherever the limy formations prevail, are fertile and especially adapted for raising such lime loving plants as the clovers and wheat of which these soils will produce large yields of superior quality. North of these more fertile soils, the soils are derived from the Genesee, Portage and Chemung strata similar to those previously discussed.

LIBERTY TOWNSHIP

This township lies east of Howard and Curtin with the Clinton county line for its eastern and the Bald Eagle Mountain for its southern boundary. The soils of the township are derived from the Clinton shales, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus, Hamilton, Genesee and Chemung shales, the Catskill red shale and the Pocono sandstone. With the exception of the Catskill and the Pocono soils, the soils of this township are similar to those of Howard, except where Mars and Bald Eagle creeks join, the valley widens and a larger area of soils derived from materials from higher elevations brought by the streams occurs which are similar to those previously discussed and of similar capacity.

The following townships and parts of townships lying south of the Bald Eagle Mountain have soils largely derived from the Silurio Cambrian limestone. Half Moon, Ferguson, Patton, College, Benner, Spring, Marion, Walker, Potter, Gregg, Penn, Haines and a narrow strip of central Miller township.

HALF MOON TOWNSHIP.

This township lies south by east of Taylor and Worth townships with the Blair county line for its western boundary. The soils of the township are derived from the Silurio Cambrian limestone, the sandy measures or "Barrens" of this formation which cover about half of this township. The northern boundary of the township is made by the Bald Eagle Mountain, the soils of which are derived from the white Medina sandstone with some of the red Medina and Oneida not of any agricultural value.

Along the lower slopes of the mountain and paralleling the limestone soil above referred to the soils are derived from the underlying Utica and Hudson River shales and the alluvial material brought down from the mountain. These soils are usually deep, well drained, easily farmed, early spring farming soils with fairly large water and fertility holding and crop accommodating capacity. The regular farming and the heavier truck crops thrive well here. These soils will produce an early or late fall sown early summer forage or green manuring crops such as rye and winter vetch, followed with a ninety-day corn crop or cowpea crop or a later fall ripening truck crop.

In the valley between the Bald Eagle Mountain and Buck or Chestnut Ridge, the soils are derived largely from the Magnesia limestone and the sandy and cherty materials of this underlying formation with such a limited water holding capacity that a short drought will considerably curtail production; but even with a sufficient rainfall agricultural crops will not yield such returns as the sources from which these soils are derived would lead one to expect. These soils are very deficient in organic matter because it decomposes at a wonderful rate and which if a superior leguminous organic matter could by some means be supplied it would increase the productive capacity of the soils to double what it is at the present time. The soils of Buck or Chestnut Ridge are derived from a sandy material occurring in the limestone formation, from which the soils previously discussed are derived. These soils range from stony light and heavy sandy to clay loams with a still more limited water holding capacity than the soils surrounding this whole area. The land is rolling and hilly with some sandy ridges. The clayey loams are the types that are farmed and are especially adapted for raising such crops as will make

their main growth during the spring season when the rainfall is more abundant, or for raising fruit, such as cherries and small fruits which also set and develop their fruit during this season.

It seems that in the loams and the clays throughout and on the borders of this formation, such dry weather crops as Kaffir corn and buckwheat, among the grains, and among the legumes, the cowpea, sweet and Mammoth clovers could be grown both as soil improving crops and for roughage for animals, and by them these soils made to yield inviting financial returns. The stony and sandy and dryer types should be used as they now are for growing timber.

PATTON TOWNSHIP

This township lies east of Half Moon and south of Huston. The soils of the township are derived from the same underlying rock formation as those previously discussed, except that a cove with rather deep warm large water and fertility holding, fruit especially apple soils, derived from the more easily disintegrated red Medina sandstone exists, back of the Oneida terrace on Bald Eagle Mountain, and that the soils between Buffalo Run and the foot of the mountain are derived from the upper or Trenton strata of the limestone formation and are more fertile than those previously discussed and to be referred to later and further that the sandy strata disappear in the eastern part of the township.

BENNER TOWNSHIP

Benner township lies east of Patton and south of Union. The soils of the township are derived from the same geological formations as the townships previously discussed, except that the area of soils derived from the sandy rock of the limestone formation is limited to a small section in the center of the township. The soils along the southern slope of Bald Eagle Mountain and behind the Oneida terrace are similar to those previously referred to. The limestone soils with the exception of small areas and those of the central part of the township previously referred to belong to the clay loams. The land is usually rolling except along the streams especially along Spring Creek where it is hilly, the same type of soils occur on the slopes of these hills and on the ridges as well as on level areas. These soils are derived from the magnesia limestone and contain a sufficient amount of sandy material to make them so friable that even when plowed wet, only the clayey sections clod when the land becomes dry, while the loamy areas can readily be put into fine tilth. These are among the richest soils of this county and are adapted for raising the regular farm crops, especially corn and wheat among the cereal grains, and red, alsike and Mammoth clovers and alfalfa among the

long season legumes, crimson clover and winter vetch among the fall sown early summer ripening and the Canada field pea, the soja bean and the northern grown cowpea among the late summer or early fall ripening types. With the array of crops enumerated, in soils like these because of their natural underground drainage and their formation, early or late fall sown crops can make an early start and because of which the land can be prepared early and seeded or planted with cool weather crops, a rotation can be arranged by means of which the production of roughage and grain can be greatly increased and growing crops can be maintained on the land throughout the growing season as well as during the winter, and in this way the fertility that is made available and which through the natural underground drainage is carried away can be stored in plant systems and fed to animals and the manure applied to more growing crops and in this way the organic matter in which these soils are very dificient be supplied and their fertility be maintained and even increased. Nittany Mountain makes the southern boundary of this township.

SPRING TOWNSHIP

This township lies east of Benner and south of Boggs with Bald Eagle Mountain for its northern and Nittany Mountain for its southern boundary. The soils of the township are derived from the same geological formations as those of Benner township with similar capacities and adaptations. The eastern part of this township is a high largely gently and moderately rolling country in which few outcrops of limestone and few sinkholes occur. Bellefonte, the county-seat of this county, is located in the northwestern part of this township, facing the beautiful Nittany Valley and mountains. Within the limits of this town are extensive limestone exposures of which the following analysis give the composition of the upper, middle and lower strata.

2nd Geo. Survey, Pa., Page 313.

	Upper	Middle	Lower
Carbonate of lime, ...	97.890	98.322	97.532
Carbonate of magnesia, ...	1.285	1.170	1.210
Carbonate of iron, ...	2.03	0.320	377
Alumina			
Insoluble residue, ...	0.540	0.390	0.815

This limestone is sufficiently pure for such industries as need a pure lime and splendidly adapted for agricultural purposes.

MARION AND WALKER TOWNSHIPS.

These two townships, the former lies south of Howard and Liberty with the Bald Eagle Mountain on its northern boundary and the latter lies south of the former with Nittany Mountain for its southern

boundary. The soils of these two townships are derived from the same geological formation as those previously discussed, except that along the dividing line between the two townships is a dry ridge with outcropping sandy limestone, making a sandy soil similar to the soils discussed in Half Moon and Patton townships to which the reader is referred. The limestone soils of Marion township are largely the clay loams, while those of Walker are the loamy types and are not as productive, but with a crop arrangement to produce a larger amount of available organic matter in which these soils are very dificient, to be applied in connection with the excrement of the animals or to be plowed down it seems the productive capacity of these soils could be increased considerably. Small areas of soils derived from the Medina red sandstone throughout the Nittany Mountain are well adapted for raising apples.

FERGUSON TOWNSHIP

This township lies south of Half Moon and Patton townships with the Huntingdon county line for its western and southern boundary. The soils of this township are derived from similar underlying rock as those of Half Moon and Patton townships and are similar in capacity and adaptation. The sandy formations cover approximately two-thirds of the area of the township.

COLLEGE TOWNSHIP

This township lies east of Ferguson and south of Patton. The land is rolling. The soils are derived from the underlying limestone and belong largely to two types, the clays and clay loams. The rock crops out in many places while in others it comes so close to the surface that only a thin layer of soil overlies it which when the rainfall is deficient, soon dries out and crop yields are materially reduced. In most places the underlying rock lies within five or six feet from the surface especially in the clays while in the case of the clay loams the soil is frequently deeper. These soils are drained through natural underground channels and are seldom, except in the spring of the year or during abnormally rainy seasons, too wet for farming operations. These soils are not as warm as the more loamy types, and early or late fall sown winter crops do not make as early a start in the spring as in the more loamy types; neither can these soils be prepared and seeded as early in the spring, but after growing weather comes crops will grow so much faster in these soils that within a shorter time they will produce larger crop yields than the other types will. These soils are quite deficient in organic matter, and to produce and supply this organic matter and to prevent the leaching through the natural underground drainage of the available fertility,

such a rotation should be adopted by means of which a soil improving crop, could at all times be kept growing on these soils, either in connection with or following a soil exhausting crop and should either be fed to animals or used as absorbents of the animal excrement and applied on the soil, or the crops should be plowed down. These soils will produce all the cereal and leguminous crops previously enumerated in the discussion of other types and therefore such a rotation can readily be worked out as will supply both the grain and roughage required to engage in any of the various phases of animal husbandry. The nose of Nittany Mountain penetrates this township to its center.

HARRIS TOWNSHIP

Harris township lies south of College, with the Huntingdon county line for its southern boundary. The limestone soils of the township belong largely to the clay loams and are similar to those previously discussed. Along Seven Mountain, the soils derived from the mountain debris, the Utica and Hudson River shales and slates, are similar to to those discussed in other townships. In the southern part of the township on top of Seven Mountain is a swamp known as Bear Meadows around which some good pasture land could be developed.

POTTER TOWNSHIP

This township lies east of College and Harris, with the Mifflin county line for its southern boundary. The soils of limestone derivation belong to the loamy types and are similar to those previously discussed. A large area of hilly land with stony, gravelly, sandy, loamy and clayey types of soils occurs along the seven mountains similar to these types discussed in connection with other townships.

GREGG TOWNSHIP

This township lies east of Potter on the Mifflin county line. The soils are derived from the Medina and Oneida sandstone, the Hudson River shales and slates and the limestone. Brush Mountain crosses the township from east to west ending along the eastern boundary of the township. Brush Valley, the soils of which are derived form limestone, parallels Brush and Nittany mountains, the soils along the sides of which are derived from the Hudson River shales and are similar to those previously discussed. The surface of Brush Valley is quite uneven because of the numerous underground caverns, the roofs of which have fallen in; and while the sides have become rounded, still there are numerous outcrops of rock making difficult farming in many places. The land is fertile, the soils usually deep except where the rock outcrops, and produces large yields of the regular farm crops and is adapted to the raising of the same types of

crops as previously discussed. Egg Mountain or Egg Hill contains an outcrop of Medina red sandstone in the western part of the township, while the remainder of the ridge, as it dies down eastward, is made up of the Hudson River shales at the terminous of which the soils are derived from the black carbonaceous shales overlying the limestone which make a soil equally as fertile as the limestone and more easily farmed, adapted especially for raising clovers and all lime loving plants such as wheat, of which it produces fairly large yields of good quality. A considerable area of soils derived from the Medina red sandstone occurs in the mountain, splendidly adapted for apple raising. With these exceptions the soils of the township are similar to those previously discussed.

PENN TOWNSHIP

This township lies east of Gregg, with Brush Mountain for its northern and Paddy Mountain for its southern boundary. The soils are very similar to those of eastern Gregg, except that the limestone clays are the prevailing types, with numerous outcrops of limestone similar to those previously discussed in other townships. A considerable area of sandy soils derived from the Medina formation occurs along Poe Valley, which it seems should produce fruit especially on the higher elevations.

HAINES TOWNSHIP

This township lies east of Penn, with Brush and Big mountains for its northern and Paddy Mountain for its southern boundary. The soils are derived from the limestone, the carbonaceous shales overlying the limestone, the Hudson River shales and slates, the Medina red and grey sandstone and Oneida white sandstone. The limestone soils are largely the clay loams with fewer outcropping of limestone than in the previous townships and with a larger area of the carbonaceous shale soils than in the previous township. The eastern part of the township is hilly and mountainous and the areas of farming land limited and difficult to farm.

CLINTON COUNTY

Clinton county was organized by an Act of the Assembly of Pennsylvania in 1839 from parts of Centre and Lycoming counties. It contains 561,920 acres, of which 120,619 acres is land in farms, and of which 67,542 acres is improved farm land. 10,154 acres were planted in corn in 1909, yielding 225,895 bushels; 8,419 acres were sown with oats, yielding 195,168 bushels; 9,253 acres with wheat, yielding 145,-

201 bushels; 1,065 acres with buckwheat, yielding 10,492 bushels; 1,000 acres with rye, yielding 10,219 bushels; 1,567 acres were planted with potatoes, yielding 114,313 bushels; 355 acres with tobacco, yielding 332,364 pounds; 13,324 acres were sown with all forage crops, yielding 14,645 tons of various kinds of hay. Of the 67,542 acres of improved farm land, 45,137 are used for raising farm crops, while 22,405 were not so used and were likely producing weeds. At this time Clinton county had a population of 31,545 people to feed, 8,669 cattle, 3,048 horses, 60 mules, 6,189 swine and 1,548 sheep.

The county lies west of Lycoming, north and east of Centre and east of Cameron and south of Potter. The outcropping rock strata from which the soils of this county are derived begin, like those of Lycoming, with the coal formation and range from these down through the Devonian and Silurian strata, until the oldest limestone formation is reached, in the southern section of the county; representing approximately 23,000 feet of rock strata made up of the coal measures, conglomerates, red shales, Pocono sandstone, Catskill red sandstone, Chemung, Portage, Hamilton and Marcellus shales of No. 8, the Lower Helderberg limestone, the Clinton red shale, Medina and Oneida sandstone and the Silurio Cambrian limestone in Nittanny and Sugar valleys. The county is drained by the West Branch of the Susquehanna River and its tributaries. The river flows into the county in a northwesterly course from Centre county, then changes to an easterly direction and then southeastward and flows into Lycoming county near Jersey Shore. The Sinnemahoning River flows into the Susquehanna at Keating. Besides this large stream, a large number of smaller streams such as Kettle Creek, Young Womanstown Creek, Ryners Run, etc., drain the northern section; while the southern section is drained by Bald Eagle Creek, Big Fishing Creek, Mill and Nippenose creeks.

GREENE AND LOGAN TOWNSHIP.

These townships occupy the southeastern and southern section of the county along the Centre county line. The soils of Greene township on the plateau of Nittany Mountain are formed from the disintegrated underlying sandstone. Where the upper hard Medina sandstone has been removed from the softer red formation the soils are fairly fertile and produce good crops of a superior hard red wheat, mealy potatoes, and when limed, red and alsike clovers, Canada field peas and oats yield fair crops, especially with the application of some fertilizer such as phosphoric acid. The best paying crop here is apples, especially the Baldwin. In some places these soils are wet and seem to need underdraining, but which it seems to me could be remedied by the use of deep tillage machinery.

Along the sides of this mountain the soils are rough and stony, and in many places, too steep to farm. In other places the talus from the higher elevations has and continually is covering the mountain side with so much of only partially disintegrated material, that even trees do not thrive. Along the lower slopes, adjoining the limestone formation, the Hudson River and Utica shales form the soil. Here are many rounded hills with more or less easily farmed, gentle slopes, and again hills with deep slopes more difficult to farm. These soils will produce fairly large crops of hard red wheat, of better milling quality than the limestone soils will, and it seems a rotation of crops for wheat raising should be adapted to raise this cereal on these soils in connection with the clovers to maintain the fertility and increase the yield.

These Hudson River and Utica shales occur on both sides of Sugar Valley in this township. The limestone soil of Sugar Valley is equal in fertility to any soil in the State and is equally as productive. This valley is from 1 to $1\frac{3}{4}$ miles wide and 17 miles long, containing approximately 14,000 acres of land. A railroad has been built into this valley and access to markets is possible; but even with market facilities such as this railroad affords the farmers in the valley should make the finished products on their farms so as to sell only the least fertility off their land. The butter, pork and beef producing industry would make such farming operations possible. These soils will produce all agricultural crops that will thrive in this section of the State.

LOGAN TOWNSHIP

Lies west of Greene and approximately half of Sugar Valley lies in this township. The soils of the township are formed of similar underlying strata, except Cherry Valley running parallel with Big Mountain. This valley contains the Clinton shales though geologically higher than the surrounding mountain formations, yet because of the downward curve of the underlying rock, the higher geological strata are lower and the lower geological strata higher. Cherry Creek flows through this valley and has some farming land along its course but the greater part is of little value for this purpose. The remaining soils are similar to those already discussed in Greene township.

CRAWFORD TOWNSHIP

This township lies north of Greene along the Lycoming county line. The soils of this township are formed of the Medina and Oneida sandstone, the Hudson River and Utica shales and Cambrio Silurian limestone. The southwestern and the southeastern sections of the township have soils formed of the red sandstone, of Formation No. 4, well disintegrated, moderately rolling and of fair productive capacity.

These soils should be used for raising such crops as wheat, oats, potatoes, and among its clovers the Canada field pea and the alsike and if possible alfalfa. As already indicated, the Baldwin apple thrives well here. A large section of Nippenose Valley extends into this township from Lycoming county.

As stated in the discussion of Limestone township, Lycoming county, the soils on the mountains which rise from 800 to 900 feet above the valley are formed of the Medina and Oneida sandstone, while those along the lower slopes are formed of the disintegrated Hudson River and Utica shales, and those of the valley, of the limestone, is equally true of this part of this valley. The soils in the valley and on the sloping lower hillsides are fertile and will produce all agricultural crops that thrive in this section. This valley is easily accessible through Nippenose Gap in Nippenose township, Lycoming county.

LAMAR AND PORTER TOWNSHIPS

The former lies west of Crawford and Wayne townships and north of Greene while the latter lies west of the former and north of Logan township on the Centre county line. The soils of these two townships are formed from the same underlying rock strata and therefore are very similar. Cherry Valley lies on the southern border of both townships and between it and Nittanny Valley, Big Mountain forms an almost impassible barrier containing little or no farming land, while on the northern boundary, Bald Eagle Mountain forms well nigh an equally formidable barrier in Porter township, with some farming land on the Utica shales, where this formation and the limestone of the valley intermingle in the structure of soil. Nittanny Valley is simply a continuation or an enlargement of Nippenose Valley, or it is an enlargement of the Cambrian limestone formation, which appears first in Mosquito Valley to the north in Lycoming county and continues enlarging throughout Centre and Huntingdon counties, until it reaches southern Blair county, when it begins to contract, and in northern Bedford county disappears, to reappear in Snake Spring and Colerain townships in Bedford county, to finally disappear permanently from Pennsylvania soils in this section of the State. The section in Clinton county of this extensive outcrop of this ancient limestone formation, while comparatively narrow, contains among the most productive soils of the entire outcrop. The soil is easily farmed and will repay the application of all that is best in advanced farming. In this valley, as in Sugar Valley, the farmers should make, in so far as possible, the finished products on their farms. Further southwest in Centre county all streams disappear from the surface of the central part of this valley and flow under ground, whereas this section of the valley is well watered by surface streams.

The limestone of this formation will burn into very fine lime for agricultural purposes. This is one of the naturally fertile valleys of the State, adapted to all agricultural crops that thrive in this section. Alfalfa will yield large crops here. Limestone occurs in inexhaustible quantities throughout this valley. Wayne township lies northwest of Lamar and west of Crawford and has the Susquehanna River for its northern boundary. The strata from which the soils of this township are formed range from the Hudson River shales along McElhatten River to the Lower Helderberg limestone which, however, does not outcrop along the mountain to any large extent and is not quarried because usually covered up with a heavy talus. In the curve of the river in the northern part of the township is a beautiful valley of fertile soil, largely composed of drift but underlaid likely at considerable depth with the Lower Helderberg limestone. This section is especially adapted to intensive farming because, like the drift soils in Lycoming county, these soils are with careful farming inexhaustible. The Clinton shale formation is narrow and contains little agricultural land. Some of the uplands on the Medina red shale are similar to those already discussed in connection with Crawford and Greene townships.

PINE CREEK TOWNSHIP

This township lies north of Wayne and has the Susquehanna River for its southern and Lycoming county line for its eastern boundary. The strata from which the soils of this township are formed are the same as those of Porter township, Lycoming county, except that Pine Creek has a larger area of Catskill in the northern part than Porter. These strata range from the Lower Helderberg limestone up through the Catskill, in the northern part of the township. The Catskill formation is very hilly and farming is attended with difficulties of such a character, that it is not a paying proposition except where apples can be grown. The Chemung, which here include the Marcellus and likely the Genesee formation, is not as hilly and the soils are of a better type, than the Chemungs usually are.

The valley along the river and Pine Creek is the same as the Williamsport Valley, and in this township is as wide and even wider and equally as fertile as in Lycoming county and adapted to intensive farming of the highest developed type possible in this section. It is one of the intensive dairy sections of the State for which a succession of crops should be worked out, that will yield the largest amount of roughage and grain in which corn and the clovers both for roughage and for grain should occupy the prominent places. This valley extends westward through southern Dunnstable, northern Wayne, as already indicated, central Allison, southern Bald Eagle and southern Beech Creek. The soil all along from the eastern to

the western end of the township is formed in a similar way and of the same materials and is of equal fertility and adapted to the same intensive farming above referred to. North of this valley and running parallel with it, are the Chemung soils extending through the same townships, except Wayne, to the western end of the county.

DUNNSTABLE TOWNSHIP

Dunnstable township lies west of Pine Creek, and like Pine Creek, the Chemungs are more rolling and less steeply hilly and the soil more fertile than Chemungs usually are. The northern part is very hilly and the soil derived largely of Pocono sandstone extends along the side of the Allegheny Mountains.

WOODWARD TOWNSHIP

Woodward township lies west of Dunnstable and has the Susquehanna River for both the southern and western boundary. The Marcellus limy shales enter the formation of the soil along the northern border of the Bald Eagle Valley, and wherever this occurs the soil is more productive than in the valley where the limy shales do not go directly into the formation of the soil. This is especially true of Woodward township. Northward as the mountain is approached the land becomes more hilly and is not so well adapted to farming, but a number of sections are splendidly adapted for raising apples.

ALLISON TOWNSHIP

Allison township lies west of Woodward and has the Susquehanna River for its eastern boundary. The strata begin with the Medina and Oneida sandstone which form the crest of Bald Eagle Mountain and end with the Pocono sandstone in the northern part of the township.

Lock Haven, the county-seat of Clinton, is located along the river in the beautiful Bald Eagle Valley and, as already indicated, is surrounded with a very fertile and well farmed country. The land in this vicinity is adapted to market gardening and trucking, while the soil along the Chemung hills will produce fruit especially apples. The Lower Helderberg outcrops between Lock Haven and Mill Hall.

BALD EAGLE TOWNSHIP

Bald Eagle township lies west and northwest of Allison. Bald Eagle Mountain forms the southern boundary and the Susquehanna River the eastern. North of Allison township the strata from which the soils of the township are derived, range from the Bald Eagle Mountain, formed of the Medina and Oneida sandstone to the coal measures.

These strata include the Medina, and Oneida sandstone, the Clinton shale, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus, Hamilton, Genesee, Portage and Chemung, the Catskill, the Pocono sandstone, the Mauch Chunk red shale, the Pottsville conglomerate and the coal measures. Few counties in the State have so extensive a series of geological strata.

Big Fishing Creek gaps the Bald Eagle Mountain and flows into Bald Eagle Creek near the southwestern corner of Allison township. Bald Eagle Creek curves northward before Fishing Creek empties into it, and forms a beautiful and fertile valley extending through the entire southern section of this township. At the mouth of the Fishing Creek Gap the Lower Helderberg limestone (probably the Niagara) outcrops. This is a fairly good stone, amply pure for agricultural purposes. In this township the Bald Eagle Valley begins to narrow and the Oriskany sandstone, which usually accompanies it, appears in sandy formations along the valley.

BEECH CREEK TOWNSHIP

Beech Creek township lies directly west of Bald Eagle township on the Centre county line. The geological strata are exactly the same as those of Bald Eagle, except that there is more of an outcrop of Oriskany sandstone than has appeared at any place in this or Lycoming county. The soils are very similar to those of Bald Eagle and need no further discussion here.

GALLAGHER TOWNSHIP

Gallagher township lies on the eastern border of the county with only Pocono sandstone, Mauch Chunk red shale, conglomerate strata and coal measure rock for the basis of its soils. All the township is high, with steep hillsides, difficult of access, with poor soils, except in a few valleys along the streams and an occasional upland that will pay to farm. A divide runs through the southern part of this township and across into northern Woodward upon which some agricultural soils occur, but it is narrow and high.

COLEBROOK TOWNSHIP

Colebrook township has little farming land. The same is true of northern Bald Eagle.

GRUGAN TOWNSHIP

Grugan township lies west of Gallagher, with Pocono, Mauch Chunk red shale conglomerate and a few patches of coal strata for the basis of its soil. The river valley is rather wider here than normal through this county in the Allegheny Mountain section, and some fairly good farming land occurs in this valley formed of the materials brought

down by the streams and deluvial from the mountain side. This material contains little fertility and therefore these soils are not fertile naturally.

NOYES TOWNSHIP

Noyes township lies north of Grugan and north of Beech Creek, with soils formed of the same strata as the previously discussed township. The Susquehanna River flows through the northern part of this township. Along this stream are some of the same type of soils that occur along the river in Grugan township further south.

A ridge known as the hyner anticlinal rises high above the surrounding mountains, extends across and beyond the township in a northeast and southwest course and occupies nearly the whole of the area, south of the river, with little or no farming land.

CHAPMAN TOWNSHIP

Chapman township lies north of Noyes and extends to the Potter county line on the north. Along the southern border or rather a short distance north of the river the coal measure strata remain in the trough that passes through this and the townships west of it and with them the conglomerate rock, which in some places are covered with coal strata which make farming soils. Further north the soil is usually stony, rocky and rough. Where this is not the case and disintegration of the shales has proceeded far enough, some clay soils have been formed in places and are tough and not fertile, needing lime.

LEIDY TOWNSHIP

Leidy township occupies the northwestern part of this county. The same rock strata that cover Chapman township underlie this township and form the soil. Along Kettle Creek which flows through the township from north to south are some rolling stretches of farming land with soils largely made of deluvial and some alluvial deposits, which, where organic matter remained or was deposited with the disintegrated materials, formed a fairly fertile soil, which can be made to yield profitable returns. Otherwise the soil is similar to that of Chapman township.

EAST AND WEST KEATING TOWNSHIPS

The former lies west of Leidy on the Cameron county line and the latter lies directly south of the former and has the Cameron county line for its western boundary and the West Branch of the Susquehanna River to form the boundary between it and Centre county. Some farming land occurs along the Sinnemahoning River in East Keating township similar in formation and in fertility to that of Kettle Creek already referred to and described in Leidy township.

West Keating township, beside the Pocono, Mauch Chunk red shales and conglomerate strata, contains in the trough which traverses the whole length of the county, four of the formations of shales, sandy and slaty shales, shaly sandstone and shale, together with concealed strata aggregating more than a hundred feet of the lower productive coal formation. These shales, shaly sandstone and sandy shales form soils of splendid agricultural capacity as is well shown, by the wood growing on them at the present time.

This section, like so many in Penna., shows the effects of the composition of the underlying rock on the productive capacity of the soils. These shales evidently contain some limestone or limy shale formations, likely the latter, because some white oak timber of considerable size grows here and likely some grew in the original forest. With the application of ground limestone, which could be gotten from the Bald Eagle Valley, these soils could be made to yield splendid crops of wheat, potatoes and clovers and the more clayey of them, the hay grasses. On account of the difficulties attending an examination of this kind of the hilly township soils, it could not be as thorough as might have been desired.

The largest part of this county, north of the foothills of the Bald Eagle Valley should be reforested and the perennial burning over of these lands should be stopped by such stringent laws that no one guilty of such vandalistic offense would likely not be in position to commit a second one.

The following analysis of a specimen of limestone from Nippenose Valley in Crawford township, gives some idea of the composition of the Cambria Silurian limestone occuring in this county.

Carbonate of lime, ...	95.071% X Vol 9.9. Page 81.
Carbonate of magnesia,	1.044
Carbonate of iron, ...	0.261
Sulphate of lime, ...	0.744
Silicic acid, ...	2.660
Organic matter and water, ...	0.220

This is a pure limestone from which lime of sufficient purity can be made for all purposes for which lime is needed.

LYCOMING COUNTY

Lycoming county was formed in accordance with an Act of Assembly, April 13, 1795. It contains 780,800 acres, of which 358,209 acres is land in farms, and of which 206,547 acres is improved farm

land. 28,078 acres were planted with corn in 1909, yielding 714,840 bushels; 25,450 acres were sown with oats, yielding 561,227 bushels; 22,318 acres were sown with wheat, yielding 347,632 bushels; 9,684 acres were sown with buckwheat, yielding 146,460 bushels; 6,171 acres were sown with rye, yielding 64,282 bushels; 4,872 acres were planted with potatoes, yielding 374,152 bushels; 97 acres were planted with tobacco, yielding 107,561 bushels; 45,530 acres were sown with all forage crops, yielding 49,490 tons of various kinds of hay. Of the 206,547 acres of improved farm land, 142,200 were used in raising farm crops, while 64,347 were not so used and were likely producing weeds. At this time Lycoming county had a population of 80,813 to feed, 24,709 cattle, 9,181 horses, 121 mules, 19,087 swine and 5,812 sheep.

The outcropping rock strata from which together with the glacial drift the soils of Lycoming county were formed by the grinding action of the glacier, and by disintegration range from the coal measures on the Allegheny Plateau 2,000 feet above tide in the northern tier of townships down through the Devonian and Silurian strata to the oldest known limestone which outcrops in Nippenose and Oval valleys, the former in Limestone and the latter in Armstrong townships of this county. The following rock strata are exposed in this county.

The rocks of the lower productive coal measures, the Pottsville conglomerate, the Mauch Chunk red shale, in the Pocono sandstone, the Catskill red shale, the Chemung shale, Lower Helderberg limestone, the Clinton shale, the Medina and Oneida sandstone, Hudson River shale and the Cambria and Silurian limestone. The county is drained by Muncy, Loyalsock, Larrys and Pine Creeks, with their tributaries and smaller streams flowing into the West Branch of the Susquehanna River from the north, with smaller streams draining the hills and valleys of the southern section so flowing into the Susquehanna. Jordan, Franklin, Moreland, and in part, Penn townships, are very similar in formation and are located and adjoin each other in the extreme southeastern corner of the county. They lie east of the Susquehanna River and are drained by Muncy and Little Muncy Creeks.

JORDAN TOWNSHIP

Jordan township is the easternmost of the townships and its soils are derived from the Chemung, Catskill and Pocono rocks, the latter covering only the southeastern corner and is similar to Davidson township, in Sullivan county. The Catskill and the Chemung formations are hilly, but sufficiently rolling to be farmed. These soils will produce well when well cultivated with the exception of the more stony which should not be farmed but should remain in forest or be reforested.

The Chemung shale soils, more than well nigh any other soils, need organic matter, because they become dry readily and are chemically dead, no chemical action takes place unless organic matter, lime or commercial fertilizer is applied to stir up some activity along this line. Where the Catskill and the Chemung come together or where these two formations are close enough to each other to combine in the formation of the soil, better conditions prevail and better crops can be produced.

Wheat does well in the well disintegrated Chemung soils, especially where there is organic matter in the soils. As many as 35 bushels of wheat per acre have been raised in the better of these soils in this county. The Catskill red shales makes the basis of the soils in the eastern part of Franklin township. This formation is softer than the Chemungs and, therefore, more easily disintegrated and, therefore, less steeply hilly, with hillsides more easily farmed and more productive.

This is a splendid wheat raising soil, and so far as possible should be used for this purpose. The Chemung section of this township is very similar to that of Franklin township. The hills are rounded and planed down by glacial action and the valleys are filled some to a considerable depth and in this way are made more fertile than the Chemung hills and valleys usually are. These Chemung hills produce a more delicately flavored Baldwin apple than is elsewhere grown. The valley along Little Muncy Creek has been filled with the disintegrated and planed down materials of the hills and made more fertile while the hills have been acted on and also made more productive. This same action has taken place with all the streams and hills of this section, but with all this planing down and filling up the hills are still high and the valleys deep.

MORELAND TOWNSHIP

Moreland township lies immediately west of Franklin. The soil of this township is formed by the Chemung grey shales, the less sandy of which yield more readily to disintegration and where these sandy strata outcrop the soil is usually more fertile. In the northeastern part of this township is a divide between the tributaries of Little and Big Muncy creeks upon which some moderately rolling upland clay and loamy soils of fair fertility occur. Rye, buckwheat, oats and potatoes and timothy among the hay grasses thrive here. Timothy grows by the highways naturally.

PENN TOWNSHIP

This township lies north of Moreland and west of Franklin. All except the southern part of the township and a strip along Muncy Creek belongs to the Catskill formation. The Catskill red shales and

sandstones are the basis of the soils. Some of the uplands are moderately rolling, easily farmed and fairly productive especially when such amendments as lime have been applied.

This section should be planted with apples or at least such an acreage of it that, in connection with such crops as potatoes, oats, rye, wheat and clovers and flint corn (it seems that a developed type of this variety of corn should be the corn for this section), a succession of crops should be worked out that would make a profitable agricultural operation possible.

Foothill townships of the Allegheny Mountain:

SHREWSBURY TOWNSHIP

Shrewsbury lies north of Penn along the Sullivan county line. With the exception of narrow strips along Muncy Creek, the entire township is within the Catskill formation so that nearly all the farming soils of this township are derived from the underlying Catskill strata. South of Muncy Creek, above the steep hillsides, are some moderately rolling upland Catskill soils of good fertility and not too stony for easy farming. North of the stream and northeast of Picture Rocks, the land is hilly, and only between the various streams on the upland is there any farming soils in this township. Apple trees thrive here and, therefore, if any farming operations is undertaken it should be in connection with apple raising.

WOLF TOWNSHIP

Wolf township lies west of Penn and Shrewsbury and south of Mill Creek. The southern part of this township has soils derived entirely from the Chemung shales and some drift material along the streams. From Hughesville to Picture Rocks, along the Muncy Creek, are some of these soils either formed of the deluvium from the hillsides or material from other sources. These soils are fairly fertile, especially adapted for raising timothy hay and corn. Timothy grows native along the highway and on the borders of Woodland. East of Muncy Creek the land is more rolling and less steeply hilly than westward.

At Picture Rocks the Catskill red shale and sandstone remains in a belt about a mile wide, between the Chemung strata south and north of this place and forms a soil of better quality than the narrow Chemung belt north of it, a strong demonstration of the influence of the underlying strata on the fertility of the soil. North of the narrow section of the Chemung, already referred to, the Catskill forms the soil, most of which is rough and hilly and should be reforested as quickly as possible. Some rolling sections between Laurel

Run and Roaring Run could be farmed or planted with apples for which it seems adapted. In the vicinity of Hughesville the soils are among the most fertile in this county and are well farmed.

MUNCY, FAIRFIELD AND LOYALSOCK TOWNSHIPS

The former lies west of Wolf township and the latter west of the former. The Chemung strata are the basis of the soil in Muncy township, except in the southern part where the limestone, the Lower Helderberg underlie the soil. The same is true of Fairfield township and also Loyalsock, except on the northern border between this and Eldred and Hepburn townships, where the Catskill strata remain and enter the formation of the soil as they do in the townships to the north.

The limestone formation will be discussed in connection with the southern townships of the county. Muncy township, like all of the townships in which the Chemung strata are the basis of the soils is cut up into narrow valleys by the streams flowing from the northern sections of the county. These streams usually follow the faulty and the softer strata or the shaly formations so that in many places only the poorer soil forming strata remain. Where, however, the shaly strata underlie the uplands, there the soil is more fertile as will be indicated later.

FAIRFIELD TOWNSHIP

Fairfield township is very similar to Muncy, but is not as much cut up by narrow valleys; especially is this true of the northern section where some of the moderately rolling Chemung soils occur, but only in a limited way. Otherwise the country is hilly and not so easily farmed, except along the southern part where these Chemungs approach the limestone, especially where the strata are shaly. This same thing is true of Muncy township.

LOYALSOCK TOWNSHIP

Here the Chemung formations lies directly north of Williamsport the county-seat of this county. The lower Chemungs, where these and the limestone formations come together north of Williamsport and north of Montoursville as well as in most of the country all along where this transition occurs, the land is moderately rolling, fertile and easily farmed, and with careful farming, can be made very productive. The formations of the remainder of Loyalsock are similar to those already discussed or to be discussed.

HEPBURN TOWNSHIP

A belt of Chemung strata remain in an upward curve of the strata extending through Mill Creek, Upper Fairfield, Eldred and Hepburn townships. The fact that these strata remain is evidence that they

do not readily yield to disintegration. Between the Chemung formation to the south and this remanent, the Catskill red strata of clay forming shales and sandstones form the soil which, where the loamy and silty soils occur, are easily farmed and produce well. There are some splendid farms throughout this section especially adapted to wheat, potatoes, clovers, buckwheat, and timothy hay raising. North of the Chemungs, the Catskill soils occur again but are rougher because of the encroaching Pocono formation and are not as fertile.

PORTER, PIATT, WOODWARD AND OLD LYCOMING TOWNSHIPS

These townships lie north of the Susquehanna River. Beginning with the western boundary of the county, Porter township lies southeast of Watson, on the Clinton county line, Piatt, south of Mifflin, Woodward, south of Anthony, and old Lycoming, south of Lycoming.

All of these townships have the West Branch of the Susquehanna River for their southern boundary. The rock strata, forming the basis of the soils of these townships, belong to the Chemung and Catskill formation except along the river where this stream curves southward. Here the Lower Helderberg limestone are the underlying strata. In this discussion, only the Chemung and Catskill formation of these townships will be considered, while the limestone or river valley formation will be discussed in connection with the southern townships of the county. The Chemung strata occupy the northern half of Porter, with the exception of the northeastern corner which reaches the Lower Catskill.

The Chemung underlies all of Piatt, except a narrow belt of Catskill several hundred feet wide running through the northwestern part of the township. Here is another demonstration of which there are so many in this state, of the effects of the underlying rock in the formation and the fertility of the soil.

The Chemung strata occupy all of Woodward township, north of the curve of the river at Linden except a narrow belt of several hundred feet in width along the line between Anthony and this township on the north. The Chemung occupies all of old Lycoming north of the limestone valley, except a narrow section in the northwestern corner in which the Catskill strata remain. These Chemung strata are composed of grey shales and sandstones where the shales are the outcropping and the prevailing rocks the soil is loamy and sometimes silty.

Where the sandstone strata underlie the soil, the land is stony and the soil not as fertile. In many places these strata are nearly perpendicular or inclined at a more or less steep angle. The streams have followed the breaks or faults and the softer strata and, therefore, the sandy formations form the ridges and the soils upon any of these

ridges, where this has occurred, are stony, sandy and poor, while where the shales remain, the soil is stronger, deeper, with better water and fertility holding capacity, and with the introduction of organic matter, the application of lime and manure, can be made to produce well the crops adapted to it.

ANTHONY AND LYCOMING TOWNSHIPS

Anthony and Lycoming townships lie, the former north of Old Lycoming and the latter north of Woodward. The rock strata from which the soils of these townships are derived begin with the Chemung and range through the Catskill red, the Pocono with a little of the Mauch Chunk and ending with the bottom of the Pottsville conglomerate. These latter strata are only found on the highest summits and do not materially effect the soil. The Chemung occupies two narrow belts the one in the southern part of the these two townships and the other in the central part, the latter only about a mile wide and the former much narrower. The Catskill red clay slates and sandstone are the basis of the remainder of the soils of these two townships. With so much of the Chemung eliminated, the remaining parts of this township, with the exception of the northern sections where the Pocono comes in and makes a rough country, are composed of a moderately rolling—for this part of Lycoming county—hilly country, with well disintegrated soil adapted to farming. The hay grasses such as timothy do well here. Potatoes, wheat and clover thrive; but the best crop would be Northern Spy apples from indications existing now in this section.

MIFFLIN AND WATSON TOWNSHIPS

Mifflin and Watson townships lie, the former directly west of Anthony and the latter southwest of Mifflin. The geological strata which form the basis of the soils of these two townships range from the Chemung through the Catskill and the Pocono with small areas of Mauch Chunk red shale and the bottom of the Pottsville conglomerate in the summits of the hills.

The Chemung strata form the soil in the southeastern corner of Mifflin township, while at Sallasdasburg the Upper Chemung and the Lower Catskill intermingle in the formation of the soil. The Catskill strata form the remainder of the agricultural soils of this township and if it were not for the red clay soil Catskill slates with fairly easily disintegrated red sandstones which occur throughout this section as well as in the two previously discussed townships, there would be a much smaller agricultural area than now exists here. These soils are adapted for raising the same crops as those of the two previously discussed townships.

The area of the Catskill is much smaller in Watson township than in Mifflin. The Chemung is very similar in area and formation and composed of hilly country. The whole of the northern parts of these townships is in the Pocono, Mauch Chunk and Pottsville conglomerate formation and is mountainous with only small areas of farming land.

SOUTHERN TOWNSHIPS OF LYCOMING COUNTY

The strata from which the soils of Muncy Creek township are formed range from the Chemung, which form the hilly country in the southeastern part of the township down to the Clinton shales which forms the soils north of Muncy. At the base of the Chemung hills the Lower Helderberg limestone crops out and enters the formation of the soils, with such an affective change in its productive capacity that land values double within the limits of several hundred yards.

This limestone formation sweeps eastward from where the river begins to curve westward opposite southeastern Clinton township by Muncy Mills for a distance of more than four miles east of Muncy, from whence it changes its course westward by Hughesville, Halls and Pennsdale, in Muncy township and forms one of the most magnificent farming districts in the State, including the section beginning northwest of Pennsdale at the foot of the Chemung hills and extending southward to where the Chemung hills again rise in steep inclines south of Muncy. The Clinton shale is cut through by the river west of Muncy and forms the boundary line between this and Clinton township. The soil here is equally as fertile as elsewhere in this township.

The soil is not formed from the underlying rock but from deluvial deposits brought down by the streams from the hills and mountains surrounding this valley. Here are inexhaustible soils ranging many feet in depth adapted to trucking, dairying and intensive farming to the full limits of climatic capacities. This belt of deep fertile soil extends westward by Montoursville and Williamsport to the western limits of the county with an average width of about two miles and an approximate length of 30 miles and, therefore, contains about 60 square miles, or 38,400 acres well nigh every acre of which could be made to be improved farming land of the highest type with a productive capacity not excelled anywhere in this section of the State. An intensive agriculture, suited for the climatic conditions of this section, and one that would, with a dairy, keep up or even increase the fertility of the soil, would be corn, a deep rooting clover such as alfalfa, with Canada field peas and oats, the soja bean grown with a large roughage yielding silage corn and with a highly developed grain yielding corn that will ripen within the limits of the season, should be established.

The soil of this valley produces splendid crops of wheat, corn, oats, and the hay grasses as well as the clovers such as red and alsike and an equally intensive rotation for producing these crops could be worked out, where the dairy or animal husbandry industry is not desirable. This is one of the milk dairy sections of this State and should be developed for this purpose. The high in butter fat Holstein cow is the animal for this section.

99, Page 157.

The following analysis show the composition of the limestone of several places in the western part of the valley.

Sample No. 1 from near the mouth of Pine Creek.
Sample No. 2 from about half a mile from Pine Creek.
Sample No. 3 near Jersey Shore.

	No. 1.	No. 2.	No. 3.
Carbonate of lime, ...	72.156	60.964	70.589
Carbonate of magnesia, ...	20.304	30.691	1.740
Oxide of iron and alumina, ..	1.600	1.330	4.660
Sulphur, ...	0.167	0.100	0.024
Phosphorus, ...	0.005	0.003	traces
Insoluble residue, ...	5.570	6.960	21.680
	99.802	100.048	98.693

CLINTON TOWNSHIP

Clinton township lies west of Muncy Creek township, in the curve the river makes around Bald Eagle Mountain. The strata from which the soils of this township are derived range from the Medina and Oneida sandstone which form the crest of Bald Eagle Mountain up to the Chemung in the southern part of the township. The Clinton shale forms the soil of the north side of the mountain and extends to and beyond the river in places and is rather too steep in many places for farming except where the river curves a little away from the hills. The same formation underlies the southern slope of the mountains and here as the slope lessens some splendid farming land is derived from these shales. Most of these soils are deep, well disintegrated and make good potato, wheat, clover and corn soil. The Helderberg limestone crosses the river from Muncy Creek township south of the Clinton shale and unites with the Clinton shale in the formation of the soil. South of the limestone the Lower Chemung shales a little of the limestone the remnants of a deposit brought down by the streams form higher elevations form the soil of the valleys, while the Chemungs form the soil of the hills south of the limestone. The terraces along the opposite side of the river referred to in the discussion of Northumberland county will help to explain conditions here.

BRADY TOWNSHIP

Brady township lies southwest of Clinton and has exactly the same strata entering the formation of its soils as those of Clinton, except the Oneida and Medina sandstone. The easily disintegrated Marcellus, largely covered up by drift materials—for such the strata seems to be—form low hills, well rounded, easily farmed, fertile and productive, well adapted for corn raising, the hay grasses, such as timothy. Oats does well here, and in the more gravelly and loamy soils, potatoes.

WASHINGTON TOWNSHIP

This township lies west of Brady township and west and north of Union county and east of Clinton. The township projects southward into Union county. The rock strata from which its soils are derived range from the Medina and Oneida sandstone, which form the crests of Bald Eagle Mountain on the northern border and White Deer Mountain on the southern, up to the Marcellus and probably Hamilton shales and slates in the eastern part of the township. Below the crest of these mountains, one of which, the northern is 1,900 feet above tide, the Clinton shale forms the soil of the western part of White Deer Valley. The higher or more elevated parts of the Clinton shale formation is covered with sandstone boulders and is only fit for forests. Further down the mountain side disintegration has not proceeded far enough to make agricultural soil, and this section should, therefore, be reforested or brought into forest wherever possible. Toward the central part of this White Deer Valley the Lower and Upper Salina shales come in, especially the Lower, and enter the formation of the soil, and as is usually the case, make a fertile soil adapted for the raising of all agricultural crops, especially hard wheat. These soils usually have sufficient lime for all agricultural purposes. The Lower Helderberg limestone makes a curve into the township westward to the vicinity of Elimsport and then turns eastward and crosses into Union county. This limestone is quarried along this formation and burned for agricultural lime. This stone also enters the formation of the soil. The Marcellus shale, which comes into the eastern part of the township, is similar to that of Brady township. This valley, which is only 800 feet above sea level, is surrounded with mountains 1,900 feet above tide which makes it one of the sheltered places of the State.

ARMSTRONG TOWNSHIP

Armstrong township lies north of Washington and west of Clinton and has the Susquehanna River for its northern boundary. The rock strata of this township range from the Medina and the Oneida sandstone on the Bald Eagle Mountain down to the Trenton limestone

No. 2 in Mosquito Valley. The Hudson River shale is the basis of the soil in the northern slope of the mountain up to its crest where the sandstone comes down. There is little farming soil along this northern slope and only a narrow strip along the river. On the top of the mountain east of Mosquito Valley, where the strata of the softer red sandstone cover the surface, a rather rough soil has been formed and some farming is done here. It seems that these soils are adapted for apple raising and should, as far as possible, be used for this purpose. Beside this one section, the soil formed of the Medina and Oneida sandstone is not fitted for farming. Mosquito Valley in the central western part of this township is a hollow, scooped out down through the Medina and Oneida sandstone and through the Hudson River shales to the top of the Trenton limestone which is only 800 feet above sea level, while the surrounding moutains are from 1,600-1,700 feet above tide. The agricultural soils in this valley are formed of the Hudson River shales and are fertile and farmed to the foot of the mountain. The market for the farm products of this valley is Williamsport by road through the valley of Mosquito Creek.

LIMESTONE TOWNSHIP

Limestone township lies west of Armstrong and north of Washington on the Clinton county line. It is largely occupied by Nippenose Valley, oval in shape, about 800 feet above sea level, while the mountains surrounding it are formed of the Medina and Oneida sandstone with little or no agriculture land and range from 1,700-1,800 feet above tide. The valley extends into Clinton county, is about ten to eleven miles long and from three to four miles wide, with soils formed of the Cambria Silurian limestone and the Hudson River shales. These latter shales make the soils on the lower slopes of the mountains and immediately above the limestone, while the soil within the valley is derived from the disintegrated limestone and the shales and some of the sandstone brought down into the valley and still remaining in the soil. This soil is very fertile the clay types especially adapted for wheat, corn, oats, timothy, red and alsike clovers, and alfalfa and the loamy and gravely formations for wheat, clover and potatoes. In this valley the farmers should, as much as possible, sell only the finished products such as butter, milk, pork, beef and flour and keep on the farm all the fertility contained in the straw, hay excrement and the by-products from wheat and corn.

Several of the streams flowing in from the southeastern corner of the township unite near Collomsville and soon sink and flow beneath the surface through the limestone formation. In this southeastern corner of the township on the hills the Medina red sandstone is the outcropping rock, and being more easily disintegrated than the

other strata of this formation, it makes a section of farming land more fertile than any Medina soils examined in the State. This formation extends along the southern to the southwestern part of this township and in many places is equally fertile. The following analysis gives an idea of the composition of the limestone of the Nippenose Valley.

Pa. 2nd Geo. Survey, Vol. GG, page 81.

Carbonate of lime,	95.071%
Carbonate of magnesia,	1.044 "
Carbonate of iron,	0.261 "
Sulphate of lime,	.744 "
Silicic acid,	2.660 "
Organic matter,	.22 "
	100.000

BASTRESS TOWNSHIP

Bastress township lies north of Limestone and south of Susquehanna. The outcropping rock strata belong to the Hudson River shales and Oneida and Medina sandstone. The former forms part of the Nippenose Valley and contains some farming soil, already referred to, while the middle of the latter being softer nad more easily disintegrated produces some sandy agricultural soil in the northern part of the township. The farming land of Susquehanna township has been discussed in connection with the river valley of Nippenose township beside the farming soils of the river valley, discussed in connection with this valley, this township has a strip of farming land along Morgan Run up to the plateau where the softer red sandstone of No. 4 strata form the soil.

North of the townships, previously discussed, this mountain region of Lycoming county comprising the following townships: Plunketts Creek, Cascade, McIntyre, Cummings, Pine, McHenry, and Brown. The outcropping rock strata from which the soils of these townships are formed begin with the Catskill and extend through the Pocono, the Mauch Chunk, the Pottsville conglomerate and the coal measures.

The Pocono formation covers or rather underlies two-thirds of this whole area and the soils are formed from the disintegration of these strata. From this it is evident that agricultural soils occur only in small sections or rather where the Pocono and Pottsville conglomerate are not the underlying strata. Rose Valley and Cagan House, the underlying strata of which are the Catskill red shales and sandstone, are such sections. On these formations the land is moderately rolling and fairly fertile and could be made productive.

Apples, especially the Spy, Greening and Baldwin do well here.

Well nigh this whole northern section should be reforested with white pine wherever these trees could be made to thrive. At Ellenton, in the northeastern corner of McIntyre township are several splendid apple orchards on the Pocono and what seem coal strata sandstone formations.

MIFFLIN COUNTY

Mifflin county was formed from Cumberland and Northumberland by Act of Assembly, September 19, 1789. It contains 254,720 acres, of which 143,719 acres is land in farms, and of which 94,496 acres is improved farm land. Fifteen thousand three hundred and eighteen acres were planted with corn in 1909, yielding 347,992 bushels; 11,703 acres were sown with oats, yielding 271,346 bushels; 18,670 acres were sown with wheat, yielding 287,014 bushels; 261 acres were sown with buckwheat, yielding 2,211 bushels; 566 acres were sown with rye, yielding 5,228 bushels; 1,218 acres were planted with potatoes, yielding 83,709 bushels; 18,135 acres were sown with all forage crops, yielding 21,227 tons of the various kinds of hay. At this time Mifflin county had a population of 27,785 to feed, 10,744 cattle, 4,116 horses, 457 mules, 9,508 swine and 5,706 sheep.

The county lies west of Union and Snyder, south of Centre and Huntingdon and north of Juniata. The geological strata which form the basis of the soils in this county extend from the Silurio Cambrian limestone in the Kishacoquillas Valley to the Portage strata in the central part of the county. The drainage of the county is accomplished through the Juniata River and its tributaries, such as Kishacoquillas Creek which drains the valley of the same name in the northern part of the county, Jacks Creek which drains the upper Lewistown Valley between East Shade and Jacks Mountain and smaller streams along the river westward.

ARMAGH TOWNSHIP

Armagh township occupies the northeastern part of this county, with Paddy's Mountain forming nearly the whole of the northern boundary between it and Centre county, and Jacks Mountain forming the southern boundary between it and Decatur and Perry township. The rock strata exposed in this township range from the Silurio Cambrian limestone in the Kishacoquillas Valley to the Medina white sandstone on top of the mountain ridges covering so large a part of the township. Beatty's Knob and Strong's Knob are the ends of the ridges extending from Union county westward beyond the center

of this township forming an extremely rough and hilly section with little agricultural land. Havise Valley, formed of Hudson River shale and slate, separates Paddy's Mountain and Strongs Knob and extends eastward between these two ridges for a distance of about four miles. This valley contains some farming land; but it is rough and steep except at the western extremity where it becomes more rolling and where the limestone comes up and where the Medina sandstone entirely disappears. Here is some of the best wheat soil anywhere in the State.

Freisters Valley separates Strongs Knob and Beattys Knob to the south of it. It, too, is formed of the Hudson River shale and slate and extends eastward from Seiglersville into Union County. This, a little wider, has a wider acreage of farming land and is not as rough and stony as the Northern Valley.

To the south of Beattys Knob and between it and Jacks Mountain is Lancaster Valley, also underlaid with the Hudson River strata and extending into Union county on the east. Honey Creek, a tributary of the Kishacoquillas, flows through this valley. Along this creek is some good farming land formed of the underlying shale and the alluvium of the creek. West of these three valleys and south of Paddys and north of Jacks Mountain the Kishacoquillas Valley begins in this township with the soils derived from underlying Hudson River shales along the sides of the mountains and of the Silurio Cambrian limestone in the valley.

BROWN TOWNSHIP

This township lies west of Armagh with the Centre county line for its northern boundary. The soils of the township are derived from the Silurio Cambrian limestone, the Utica and Hudson River slate and shale, the Oneida grey sandstone and conglomerate, the Medina red and white sandstone and the Clinton formation. The limestone valley, which as previously indicated, begins in Armagh township, extends through it with a width of about three miles and a length of probably seven miles. The land is moderately rolling, with deep, gravely, some loamy and clayey soils with such water and fertility holding capacity and with such crop accommodating capacities that with good agricultural practice, crops will go on growing and will produce yields during adverse seasons, such as few soils, except probably the deep loamy soils of micaceous origin in the southeastern part of the State will produce. The clayey and loamy soils will produce large yields of corn, wheat and the hay grasses as well as the legumes, among the short season fall sown, the crimson clover, the winter vetch and among the spring sown, the Canada field pea, the soja bean, the northern grown cowpea and among the long season, the

red, alsike and mammoth clovers and alfalfa. The gravely soils and those derived from a combination of the limestone along the line of contact between it and the Utica shale and Chazy limestone produce large yields of a hard, red, high milling quality wheat, as well as the crops above enumerated as being adapted for the loamy and clayey soils of limestone derivation. Along the south and north sides of this limestone valley where the Hudson River and limestone formation come together and where the more limy strata of the Utica shale occur, are some splendid potato soils which will produce large yields of fine quality.

Throughout this entire valley outcroppings of limestone of various degrees of purity occur, of which the following analysis of a sample taken from the Naginey quarry, near Naginey cave, is probably representative:

Carbonate of lime,	94.36
Magnesia,	2.10
Oxide of iron and alumina,	1.20
Silicic acid,	2.20
Total,	99.86

This stone when burned will make more than ordinarily pure agricultural lime.

The land with soils derived from the Utica and Hudson River shales and slates, north and south of the limestone valley, is hilly, with sandy, gravely, stony and rocky soils with limited water and fertility holding capacity adapted to fall sown early summer ripening crops as well as to early spring sown summer ripening crops. In these soils a rotation of crops should be worked out in which the money crops could be produced during the season of the year when these soils contain a sufficient amount of water to produce and ripen their largest crop yields. The raising of winter vetch and crimson clover seed would lend themselves splendidly to such an arrangement. Between Long and Paddys Mountain is a narrow section of soils derived from the Clinton shale and sandstone with some agricultural capacity, while the remainder of this northern part of the township is mountainous, rough, stony and not adapted to farming except in limited areas which is adapted for raising fruit, especially on those sections where the soils are derived from Medina red sandstone, which produce vigorous, disease resisting apple trees, which yield large crops of well developed, highly colored, nicely flavored fruit.

UNION TOWNSHIP

Union township lies west of Brown with the Huntingdon county line for its northern boundary. The soils of the township are derived from the same geological formation as those of Brown township

except the Clinton shales which do not outcrop in this township. The land of the limestone or Kishacoquillas Valley is moderately rolling, with some hilly sections, with similar soils, with similar capacities and adapted for raising the same crops as those of Brown township. In this as in this limestone valley of the townships previously discussed, the soils are adapted to the highest developed intensive farming that can be practiced under prevailing climatic conditions.

As previously indicated these soils produce large yields of corn therefore a corn stalk should be developed that will produce the longest ear with the largest number of rows of grains, the grains five-eighths of an inch long that can be ripened within the limits of the normal season. In this section it seems an ear of corn ten to twelve inches long with eighteen to twenty rows of grains five-eighths of an inch long could be ripened. By the production of such a corn, the yield could be made twice as large as it now is. Alfalfa also thrives here, and with these two crops, corn and alfalfa, the two great objects of farming, that of producing the largest amount of human nutrition and the same time improving the productive capacity of the soil can be accomplished. The Utica shale and Hudson River and the Oneida and Medina soils are similar to those of Brown township.

MENO TOWNSHIP

This township lies west of Union with the Huntingdon county line for its northern boundary. The limestone valley is somewhat narrower in this township, but the same soils with similar capacities and adaptations prevail, except that it seems the sinkholes and the limestone outcroppings where the limestone comes to the surface or so close to the surface that the crops cannot grow or only a very limited growth is made, are more numerous. A considerable area of Medina sand and shale soils occur in the northwestern corner of this township which it seems is splendidly adapted for apple and peach raising, at least a thorough examination should be made of this section to determine this conjecture.

EAST AND WEST DECATUR TOWNSHIPS

These two townships lie, the former along the Snyder county line south of Armagh, the latter west of the former also south of Armagh. The soils of these townships are derived from the Medina grey and red sandstone, the Clinton shale and sandstone, the Lower Helderberg limestone, the Oriskany, the Marcellus, Hamilton, Genesee and Portage of the Devonian Age. The agricultural soils of these townships are confined to the country between Jacks Mountain on the north and Shade Mountain on the south, both formed of the Medina and Oneida shales and sandstones with only here and there a patch of land

that has been or is being farmed and is providing rather a precarious existence for those who do farm it, except those who are engaged in raising fruit along accepted practical lines. North and south of these mountains the Clinton shale and the iron sandstone makes the basis of the soils, where the shale prevails and the slopes are not too steep and the soil washed away as it was formed, fairly deep soils with good fertility and rather poor water holding capacity exist, but with the possibility of increasing the water holding capacity by good cultural methods and the application of organic matter.

The sandy ridge which rises above the Lower Clinton formation on the north side of the valley, should be in forest, while the soils immediately along the Helderberg limestone and north of it makes, where the hillsides are not too steep, some of the best farming land in these townships adapted for raising wheat of which with good cultivation they will produce large yields of the hard red variety.

The Oriskany sandstone and the Lower Helderberg limestone makes a ridge both on the north and south sides of the valley, along which are some sections of splendidly fertile soils with all the qualities that make land productive and adapts it for raising such crops by means of which the farmer can take advantage of the entire growing season because these soils are seldom too wet or too dry for crops to grow. Next, the Marcellus shales extend along both sides of the valley with comparatively fertile, rather limy soils of fair productive capacity adapted for raising the regular farm crops but especially adapted for raising wheat. The Portage sandy shales and flag stones make a ridge with thin and stony soils through the central part of these townships which, however, is not continuous but disappears and reappears, while the Genesee and Hamilton slate shales and sandstone make more rolling land with deeper soils adapted for raising a greater variety of crops successfully. Farming operations should be arranged in such a way so that the least possible amount of organic matter and as small a quantity of fertility is removed from these soils so that because of the slow soil constructing processes now gonig on in these soils, will not be interferred with or retarded.

THE DERRY TOWNSHIPS

These townships lie directly west of Decatur and have for their northern boundary, Jacks Mountain, and for part of their southern, Shade Mountain and for the remainder, the Juniata River. Lewistown, the county seat, is located in this township.

The Medina sandstone forms the crest of the mountain of the northern as well as the southern boundary of the townships, as already indicated. The Clinton shales and slates make terraces similar to

those of Decatur township, except that the terraces are broader, more rolling, and more easily farmed, especially is this the case south of Lewistown, and south, east and west of Yeagertown.

Lewistown is situated on the Upper Salina shale and marl which underlie the soil here and are so limy that they produce a soil well nigh unequalled in fertility anywhere in Pennsylvania, with large water holding and such crop accommodating capacity limited only by climatic conditions. The Lower Helderberg limestone forms a ridge directly north of the town which extends eastward into western Decatur township which, in this section, is similar in formation to Derry. The Oriskany sandstone forms the crest and northern slope of this ridge. North of this ridge the Marcellus black slate, mixed with a limy formation and with a narrow strip of Oriskany sandstone, and with some disintegrated Lower Helderberg limestone, which here form another ridge, makes fertile soils which seem to be especially adapted for raising wheat, corn, and the legumes, among the short season fall sown, the crimson clover, the winter vetch, and among the spring sown the Canada field pea and soja bean, and among the long season, the red, alsike, mammoth clovers and alfalfa which here finds a most congenial soil environment. Between this last limestone ridge and Logan is a narrow valley of Upper Salina shale and marls, which widens going eastward, and which contains soils formed of similar underlying strata as these at Lewistown and of equal fertility. Between Lewistown and Kelleyville are five limestone ridges separated by the Salinas, the Oriskany and the Marcellus formations. With all these underlying strata forming the central part of this valley, there are soils of different types but all of splendid fertility; all of them adapted for raising the same crops as those previously referred to and to intensive farming.

GRANVILLE TOWNSHIP

Granville township lies west of Derry. The same geological strata underlie its soils as those of Derry, except that the Salinas are more extensive, while the Medina ridges of Jacks and Blue Mountains form the northern and southern boundaries do not cover as extensive an area. The Juniata River flows in a sinuous course eastward through the southern part of the township. The Blue Ridge Mountains forms the southern boundary line between this and Juniata county as well as the southern boundary of this township. The Medina sandstone, as previously indicated, forms the crest of this mountain with little or no farming land. On the north flank of this mountain, the Clinton shale forms the upper slope, with a prominent ridge of ore sandstone and with rough stony soils some of which can be

farmed and seem well adapted for raising apples especially on the higher elevations. As already indicated, the Juniata River flows from west to east through the southern section of this township and forms a wide plain of fertile Salina soils extending from Lewistown westward through this and parts of Bratton and Oliver. This soil will produce all the regular agricultural crops; but it seems especially adapted to the dairy and the livestock industry because large crops of corn and legumes can be raised here.

North of the Lewistown Valley and separating it from Ferguson Valley are three Oriskany sandstone and Lower Helderberg limestone ridges, already referred to in the description of Derry township. North of of the second ridge is an upland formation of these rock which according to the wood that grows on parts of it seems especially adapted to growing the wood of fruit trees. This same sandstone formation is succeeded further north by a Marcellus slate valley known as Dry Valley or "Squak Hollow" extending between these ridges to the western extremity of the county in Wayne township. These narrrow valleys are usually stony or gravelly but contain sections of fertile soils, adapted for raising a hard red wheat and a splendid quality of corn as well as the legumes. These soils need little lime but the manure, and the clayey and loamy types intensive cultivation and the plowing down to clover sods to keep them permanently fertile. Along the Philadelphia and Pittsburgh Pike, on the southern side of these ridges, are the fertile Salina and Lower Helderberg soils beginning at Lewistown and extending to and beyond McVeytown in Oliver township.

Ferguson Valley, already referred to, begins east of the narrow Kansas Valley in Oliver township and extends eastward to Kelleyville, in Derry township and lies between Jacks Mountain and the three ridges above referred to known as Lewistown Ridge. The soils of this valley are derived from the Lower Salina or Bloomsburg red shale and the Upper Salinas, composed of limy shales and marls making deep, warm, early spring farming soils with large water and fertility holding and a wide range of crop accommodating capacity. These soils, especially the loamy and gravelly types and most of the small areas of clays, are splendidly adapted for raising alfalfa and the strongly lime loving clovers because there is at all times a sufficient supply of lime in the soil to neutralize all acidity and to supply all the demands of this plant; therefore alfalfa raising should be made a specialty here. North of the Salina formation is the ore sand stone ridge beyond which there is little farming land and, except through the central part of this valley, several ore sandstone ridges

remain with some stony land splendidly adapted for peach and apple raising. The Lower Helderberg limestone is quarried in numerous places in this township for lime.

OLIVER TOWNSHIP

This township lies directly west of Granville, south of Menno and north of Bratton, with the Juniata River for its southern boundary. The soils of the township are derived from the Clinton shales and sandstone, the Salinas, the Lower Helderberg limestone, the Oriskany sandstone and the Marcellus shales. In the curve of the river south of Chestnut Ridge, as previously indicated, the soils are derived from the Upper Salina lime, shales and marls, with some alluvial deposits along the river, and are deep with large water and fertility holding capacity adapted, the more loamy and gravelly types, for raising the cereal grains, especially wheat, oats and corn and the clovers, both the long and short season, as previously indicated, while the lower, more clayey soils are adapted for raising the hay grasses such as timothy and the pasture grasses such as Blue grass. North of the river and east of McVeytown, the Salina soils narrow between the river and the Lower Helderberg limestone which makes a ridge here with fertile soils along its slopes adapted for raising alfalfa both by location and composition.

West of McVeytown where the river curves southward the soils are again derived from the Salina limy shales with some alluvial soils along the river which are comparatively level, while the Salinas are rolling and hilly, with deep, warm, early spring farming soils which, wherever they contain a sufficient amount of vegetable or organic matter, will make possible a longer growing season and largely increase crop yields as well as the possibility of growing a larger number of crops during the season. In the western part of this township, north of this Salina formation, the Lower Helderberg limestone and the Oriskany sandstone make a series of outcrops producing hilly land with comparatively deep, rocky, stony, gravelly loams as well as regular loamy soils, with good fertility holding and fair water holding capacity, especially adapted for raising wheat, of which these soils will produce large yields of high milling quality.

Ferguson Valley begins in the northern part of this township with soils derived from the Salina shales, considerable areas containing a considerable supply of organic matter in which is demonstrated what was previously stated that the crop growing season would be lengthened and the crop yields and the number of crops that could be raised, increased. North of this and Kansas Valley the Medina sandstone make Jacks Mountain with only an occasional limited section with soils adapted for raising agricultural crops.

WAYNE TOWNSHIP

This township occupies the western extremity of the county, with Jacks Mountain for its northern and Black Log Mountain for its southern boundary. There is little or no farming land along the southern boundary of this township until Sugar Valley, previously referred to, is reached. Here the Upper Salina shales make the basis of the soils of this narrow valley with similar capacities and adaptations as those referred to in the discussion of Ferguson Valley. North of the river, in the eastern part of this township, the Oriskany sandstone spreads over a broader area than anywhere in the county making a large sand flat from out of which narrow ridges project making rough land of little agricultural value. North of this sandy flat, in the eastern part of this township, the land is moderately rolling, with the deep, more gravelly, warm soils, derived from the softer Marcellus, probably limy shales of good fertility adapted for raising all the regular agricultural crops that will thrive under prevailing climatic conditions.

In the western part of this township the Hamilton sandstone and the Portage flags make a high central ridge with thin soils which washes readily, with limited water and fertility holding capacity better adapted for growing timber than any other crop, and in so far as practicable should be maintained in forest. North of both these later formations, the Oriskany sandstone and the Lower Helderberg limestone make a ridge with fertile soils at the base and along the sides wherever the formations are sufficiently extensive. Long Hollow and Kansas Valley, the latter referred to in the discussion of Oliver township, lie north of the Lower Helderberg, with deep, warm, early spring farming soils, derived from the Upper Salina lime, shales and marls, with large water and splendid fertility holding capacity as well as large crop accommodating capacity. A rotation of alfalfa and corn it seems could be practiced here and large quantities of human nutrition produced, while at the same time the productive capacity of the soils could be maintained or even increased. The distance between Jacks Mountain on the north and the ore sandstone ridge or terrace on the north side of the two valleys widens going westward until in the western part of this township the two are fully three-fourths of a mile apart and between the two lies an area of rolling and hilly land with stony, gravelly and loamy soils of fair fertility adapted evidently for apple raising of which it will produce vigorous trees that will yield fairly large crops of well colored and flavored fruit. Jacks Mountain rises 2,300 feet above tide north of this formation the highest point in this county.

DRAINAGE

The drainage of the county is accomplished in the northern part, north of Jacks Mountain by the Kishacoquillas Creek which flows east to the gap at Reedsville, and by Honey Creek which flows west and joins the Kishacoquillas at Reedsville and flows south into the Juniata River at Lewistown. The southern part of the county is drained by the Juniata River and smaller tributaries.

JUNIATA COUNTY

Juniata county was formed by an Act of March 2, 1831. The name was taken from the river which bisects the county. The root of the word means "a stone." It contains 250,880 acres, of which 173,136 acres is land in farms, and of which 102,398 acres is improved farm land. Fifteen thousand seven hundred and ninety-one acres were planted with corn in 1909, yielding 382,277 bushels; 13,331 acres were sown with oats, yielding 287,256 bushels; 17,127 acres were sown with wheat, yielding 255,975 bushels; 1,293 acres were sown with buckwheat, yielding 13,998 bushels; 1,314 acres were sown with rye, yielding 12,413 bushels; 1,524 acres were planted with potatoes, yielding 89,579 bushels; 35 acres were planted with tobacco, yielding 46,275 pounds; 20,019 acres were sown with all forage crops, yielding 20,941 tons of the various kinds of hay. Of the 102,398 acres of improved farm land, 71,356 were used in raising farm crops, while 31,042 acres were not so used and were likely producing weeds. At this time Juniata county had a population of 15,013 to feed, 10,859 cattle, 4,539 horses, 572 mules, 7,498 swine, and 4,787 sheep.

Juniata county lies south of Mifflin and west of Snyder, having Crest, Shade, Blue Ridge and Black Log mountains for its northern boundary and Turkey Ridge and Tuscarora for its southern boundary. The rock strata which form the basis of the soils of the county range from the Trenton limestone No. 2 in the Black Log Valley up to the Chemungs No. 8 in the Tuscarora Valley.

The drainage of the county is accomplished largely by the Juniata River and its tributaries. Licking Creek which flows into the Tuscarora west of Port Royal drains the northwestern section of the county. The Tuscarora Creek flowing into the Juniata at Port Royal drains the Tuscarora Valley and the southeastern and southern parts of the county. Hornings Run, Lost Creek, Cocolamus and Little Cocolamus and West Mahantango creeks, all flowing into the Juniata River, except West Mahantango, drain that part of the county lying

east of the Juniata River. Susquehanna, Greenwood, Monroe and Delaware townships occupy the southeastern corner of the county with similar underlying geological strata and with soils of similar structure.

SUSQUEHANNA TOWNSHIP

Susquehanna township occupies the extreme southeastern corner of the county, with a point extending eastward between the West Mahantango Creek and the Susquehanna River, underlaid with Lower Helderberg limestone, the Oriskany sand and the Marcellus shale, forming a fertile valley largely covered with debris brought down by both streams.

Turkey Ridge, composed of the hard Hamilton sandstone, forms the southern boundary of this township and rises about 150 feet above the valley and decreases in height going westward to the Juniata River. Turkey Valley extends westward through Susquehanna and Greenwood townships, with soils formed likely on the Marcellus shales and some Lower Hamilton measures, containing hard sandstone strata, making a thin soil which washes readily and requires very careful management to produce paying crops. In soils of this type it seems that the sweet clover should be grown wherever possible because it will grow in thin soil, will not winter kill nor burn up in hot and dry weather in the summer.

A ridge of Hamilton sandstone, similar to Turkey Ridge, passes through the northern and central parts of Monroe township westward with soils of little fertility. Between these two ridges, the Turkey in the south and this Hamilton ridge in the northern part of these townships is an outcrop of Chemung conglomerate along Quaker Run which is entirely different from any formation in this section. It occurs in large boulders and makes a rough country.

The Hamilton ridges are usually high, steep and rough in comparison with the rolling formation of the Marcellus and Genesee strata which underlie the rolling and valley soils of this section. These Hamilton ridges extend westward to Delaware township and form equally poor soils. Flintstone Ridge, composed of Oriskany sandstone, passes east and west through the northern part of Monroe township between the soft valley making Marcellus shale on the south and the equally soft Salinas on the north. The sandstone is broken up into a cherty formation which, wherever sufficient disintegration has taken place to form the finer soil particles and has well permeated the surface soil, soils of splendid fertility are produced. The Lower Helderberg limestone is quarried in a number of places in Greenwood township and is sufficient in quantity to make all the lime necessary for this township even though a large quantity is needed to make its soils productive.

DELAWARE TOWNSHIP

Delaware township lies west of Greenwood and Monroe and has Tuscarora Mountain and Turkey Ridge for its southern boundary. The mountain is formed of the Medina sandstone and the ridge east of the township of the Hamilton sandstone, while through the township the Oriskany sandstone enters the ridge to some extent. The Clinton shales form the north flank of the mountain while the Upper Salinas underlie the valley along the river, and as usual, form fertile, easily farmed, and productive soil. The southern ridge of Lower Helderberg limestone and Oriskany sandstone does not outcrop sufficiently for quarrying either of them throughout this township. Along Delaware Run the ridge is entirely washed away. North of this formation the Marcellus continue the valley until the shaly and sandy Hamilton strata appear and with them a rough country not as fertile and not as easily farmed. These formations extend along with Turkey Ridge in the southeastern section of the township to a narrow valley along Dutchmans Run, which flows on a softer formation, but the soil is not fertile. From Goodville, eastward into Greenwood township, is a ridge already referred to, of Hamilton sand, high and massive, with rough and shallow soils. Northward the country continues rough until the Fayette township line is reached. Here is a massive exposure of the Hamilton sandstone. The whole eastern part of this township is very similar to Greenwood, except that the soil is more fertile, because disintegration has proceeded deeper and less of the massive sandstone strata remain here. The Lower Helderberg limestone and the Oriskany sandstone both form ridges in the central part of this township, but they are not massive and do not seem as pure as the limestone usually are. The Oriskany sandstone is disintegrated and cherty, and where this chert is mixed with sufficient humus and disintegrated materials, the soils are fertile and will produce the cereal grains, especially wheat, remarkably well.

Between the two limestone ridges extending into the central part of the township is a belt of the Upper Salina soils of splendid fertility which will produce all agricultural crops, especially wheat, as well as the soils above referred to. These soils should never be in need of lime if farmed in the right way. In the vicinity of East Salem the Hamilton sandstone form the ridges and the Marcellus shales the valleys. Northward of this section the same Hamilton ridge, already referred to in Monroe township, forms a steep ridge between which and the Flintstone Ridge the Marcellus shales form a valley of some fertility.

FAYETTE TOWNSHIP

This township lies west of Snyder county and north of Delaware and Walker townships, Juniata county. The geological strata range

from the Hudson River slates in the Spiegelmyer Valley in the northern part of the county up to the Marcellus slate in the southeastern part of the township.

The Spiegelmyer Valley is rough, hilly and stony and the soil though fairly fertile is difficult to farm in most sections. Apple trees thrive here and seem to last for a long time. The fruit industry seems to be the thing to develop here. On both the north and south side of this valley the Medina and Oneida sandstone form mountains with little or no agricultural soils. South of this southern sandstone mountain is the "Slim Valley", which extends through the entire length of the township between Slenderdale Ridge on the south and the mountains already referred to on the north. The soil of this valley is formed of the Lower Salina brown shales and not the Bloomsburg or Lower Salina red shales. It is not as fertile as these usually are. South of Slenderdale Ridge the Salinas again form the soil but here the Upper Salina marls and limy shales cover the lower and a very fertile soil which extends over the southwestern part of the township, is formed. These soils seem only to need deep plowing, thorough cultivation, and the application of manure to make them productive. Wheat, corn,—potatoes on the more gravelly and sandy sections—and clovers will thrive here. In the southeastern part of the township the Lower Helderberg limestone is quarried and lime burned for agricultural purposes. The Marcellus slates, the Lower Hamilton shales occupy the southeastern corner of the township. South of the limestone and Flintstone Ridge there is an outcrop of Marcellus limestone about 8 feet thick that is rather unusual. The soil in this township is adapted largely to the raising of agricultural crops.

FERMANAGH TOWNSHIP

This township lies west of Fayette and has the Juniata River for its western boundary. The strata from which the soils of this township are formed range from the Hudson river slates in the Spiegelmyer Valley on the northern border up to the Oriskany sandstone in Flintstone Ridge in the southern part of the township. The soil in the northern part of this township is very similar to that of Fayette township, except that the Slenderdale Ridge is not as prominent here as in Fayette. Here are peach soils it seems of very splendid capacity. South of Slenderdale Ridge the Bloomsburg red shales outcrop, followed by the Upper Salinas which form soils equally as fertile as those of Fayette township.

South of the Gap at Grahamville to Mifflintown, the county seat of this county, is a fertile expanse of country on both sides of the river for considerable distances eastward and westward, formed of some Clinton Bloomsburg red and marly Salinas and Lower Helderberg

limestone, together with alluvial soils along the river. This is one of the productive sections of the State, adapted for dairying and general farming or for the highest type of intensive farming. The Oriskany sandstone forms a ridge in the southeastern corner of this township with outcrops of Lower Helderberg limestone accompanying it.

WALKER TOWNSHIP

Walker township lies south of Fermanagh and Fayette, west of Delaware, with the Juniata River for part of its western boundary. The outcropping strata of the township range from the red and white Medina sandstone on Tuscarora Mountain to the Hamilton shales at Mexico. The Lower Helderberg limestone, the Oriskany sandstone and the Marcellus shales occupy the northeastern corner of this township, upon which fertile soils are formed.

South of Mifflintown along the river and eastward from here into Delaware township is a splendid valley of Bloomsburg red shale and Upper Salina soil, with some rounded ridge of Clinton shale soils, all of good fertility. This formation continues south to Port Royal, in some places, on both sides of the river. South of Port Royal the Lower Helderberg limestone outcrops. This outcrop extends eastward through the township on both sides of the Marcellus formation on which Mexico is located along the river. Limestone has been quarried and lime burned along these outcrops for a long time. The Marcellus, just north of Mexico, outcrops. From Mexico eastward along the river to and beyond the line of the township is a beautiful valley on the Salinas of splendid fertility, adapted for raising all agricultural crops as well as for dairying and for trucking.

TURBETT AND SPRUCE HILL TOWNSHIPS

Turbett and Spruce Hill townships lie west of the Juniata River, with their southern line on Tuscarora Mountain. The strata that form the basis of the soil range from the red Medina sandstone and slate on the Tuscarora Mountain up to the Marcellus slate and the Lower Hamilton shale along the Tuscarora township line.

Tuscarora Mountain on the north side down to within a short distance of Sinkhole Valley is rough, with little farming land, except such as is suited for fruit raising as peaches and apples especially the former. The Upper Salina strata form the soil on both sides of the Sinkhole Valley, especiallly the northern side away from the mountain in Turbett township. In the eastern part of this township the Upper Salinas form the soil, very largely, which is fertile, easily farmed and produces all agricultural crops, especially wheat and the clovers, and the more sandy and loamy types will produce splendid crops of potatoes, because of the limestone or limy shales which occur

in this formation. North of this Salina formation the Lower Helderberg limestone and a cherty Oriskany sandstone formation forms the basis of the soil, which, wherever disintegration has proceeded far enough to form fine materials, and where sufficient organic matter has been added, the soil produces well in wet and dry seasons. The limestone is quarried along both sides of this Marcellus formation for agricultural purposes. It makes a good agricultural lime. Spruce Hill township is similar to Turbett in formation, except that the Upper Salinas cover a larger territory in Spruce Hill than they do in western Turbett. The village of Spruce Hill is situated on the Upper Salinas and is surrounded with a fertile soil; but so many ridges pass through this section and make it more hilly and more difficult to farm.

BEAL AND MILFORD TOWNSHIPS

Beal and Milford townships lie, the former directly north of Turbett and Spruce Hill and the latter north of the former with the Mifflin county line on Blue Ridge Mountain for its northern boundary and the Juniata River for the eastern boundary of both.

Going west from Port Royal along Tuscarora Creek this Salina strata form the basis of the soil, especially where the creek curves southward, is a fertile plain of Upper Salinas soils covering nearly all of the country between the Iron Sandstone Ridge and the Limestone Ridge to the western border of the township. Here are sections where this fertile soil is only several hundred feet wide, but upon which the crops are so much better that it is so obvious that farmers remark if all the soil of our farms would be as fertile as that strip running through them, usually northeast and southwest, much larger yields would be had for the same work. The Helderberg (Lewistown) limestone forms a low ridge in most places in the western part of this township, except near the western line, where it rises in a ridge of considerable height which contains a good quality of stone.

Near this western line, north of the Tuscarora creek, is an outcrop of lime shales of the Salina formation containing seams of good limestone. South of Mifflin, on the west side of the river along the railroad, is an exposure of the Salina strata that gives some idea of how these enter the formations of the soils of this section, running east and west through this township. This exposure is sufficiently high and long to reveal a thick mass of variously colored lime shales and slates with bands of grey sandstone from 5 to 15 feet thick and strata of red shale from 10 to 20 feet thick. Some of these strata stand nearly vertical, others curving in anticlinal and synclinal folds, showing what may occur in any section of this part of the county west of the river and accounting for comparatively narrow sections of fertile and again for similar sections of sandy and poorer soils. These

softer strata were crushed into the position they now occupy and there the agencies of disintegration acted on them and formed the valleys where the soft rocks occur and the narrow ridges where the folds of the harder strata outcrop.

The Academia Ridge, which begins about four miles west of the Tuscarora township line, extends through the entire length of this township and on through Walker into Delaware township, on the east. The top of the ridge in many places is flat and covered with soils formed of Clinton shales and sandstone with the iron ore sandstone outcropping on both the north and south sides and forming ridges. This section is well adapted to peach growing and these soils should be used for this purpose.

North of this ridge is the Mifflintown Valley. It begins near Allenville, near the western part of Beal and Milford, and extends for 8 miles to Mifflintown and beyond into Fermanagh township. The soil on the sides of the valley is formed of disintegrated Salina marls and the Lower Helderberg (Lewistown) limestone, both of which form a fertile soil. It is one of the most fertile small valleys in the county.

North of this valley and northward of the Shade Mountain and Lost Creek Ridge is Licking Creek Valley, which begins with Licking Creek in the western extremity of Mifflin county and extends eastward beyond the Juniata River. In the western part of this township the valley is narrow and the soil stony and rough, but within about 8 miles from the river it widens and the soil becomes more fertile. Still further east, the Salina marls remain and enter the formation of the soil which, with a mixture like this and the addition of the Lower Helderberg limestone which remains in the Valley for a distance of at least two miles west of the river, makes a soil of splendid fertility, all of which has already been referred to in the discussion of Fermanagh township. The limy soils are splendid wheat, potato, clover and corn soils, while the more sandy and iron formation should produce, especially peaches.

TUSCARORA AND LACK TOWNSHIPS

Tuscarora and Lack townships lie, the former directly west of Spruce Hill, Beal and Milford townships, with Tuscarora Mountain for its southern and Black Log Mountain for its northern boundary, while Lack township has the same northern and southern boundaries, and extends westward from Tuscarora township to the Huntingdon county line.

The geological strata that form the basis of the soils of these two townships extend from the Hudson River slates in Tuscarora township and from the top of Trenton strata of the Cambria Silurian limestone up to the Genesee in Tuscarora and to the Chemungs in Lack townships.

TUSCARORA TOWNSHIP

The northern part of Tuscarora township is hilly and even mountainous, so that there is little if any agricultural land in this section. As previously stated, the Academia Ridge extends into this township for a distance of about 4 miles. Ths section of the township is rough and hilly, with some fertile soil in the narrow valleys where the marls of the Upper Salina strata and the Lower Helderberg limestone enter the formation of the soil. McCoysville is situated on the Oriskany sandstone, while the Lower Helderberg (Lewistown) limestone is quarried close to the village, as well as some distance west of the town. The soil here is fertile and productive when well farmed, but care must be exercised to prevent washing. The limestone at McCoysville is 150 feet thick, including the shaly strata, while the pure limestone at the bottom is amout 40 feet thick. Beginning in Spruce Hill township, the high Hamilton ridge (sandstone) enters Tuscarora township south of McCoysville and south of Tuscarora Creek, which cut through it about two or three miles west of the township line. The ridge continues south of Willow Run to and beyond the western border of the township. The soil is usually poor and requires amendment, such as lime and the application of manure, and such commercial fertilizer as the soil will indicate.

In many places throughout this Marcellus, Hamilton and Genesee formation, are moderately rolling sections with fertile soils, easily farmed which, with the use of lime and manure and the plowing down of sods, will produce as good crops as the more fertile soil now do. South of this formation the limestone and Oriskany sandstone, already referred to in Spruce Hill township, continues through this township. The Oriskany forms a ridge, but it has become cherty in many places, and where this chert is mixed with sufficient finely disintegrated rock and vegetable matter, the soil is fertile.

In the vicinity of Bealtown the Helderberg (Lewistown) limestone attains a thickness of sixty feet of good limestone. About two miles east of this limestone formation, on the road running along the Oriskany sandstone ridge and the Marcellus strata, the Marcellus limestone is exposed 10-15 feet thick. South of Limestone Ridge the valley is formed out of Salina and Clinton strata and the soil though rough and in many places difficult to farm is fertile. Liberty Valley extending into Perry county, begins south of this valley. It is formed of the same strata and, therefore, has a similarly fertile soil.

The strata from which the soils of Lack township are formed, as already indicated, are the same as those of Tuscarora township, except that in the Black Log valley, limestone No. 2 comes to the surface, the only place in this county. This stone is quarried and lime made of it in this valley which, with the Huntingdon and Broadtop coal field as close as it is, should make it possible to make lime cheaply here.

The valley between Shade Mountain and Limestone Ridge is narrow and broken, with hills though containing the Salina shales and having some fertile agricultural soils as a rule is difficult to farm. Shade Valley, which approximately runs along between the Oriskany and the limestone, is narrow, with soils that should be well adapted for apples. The Lower Helderberg (Lewistown) limestone is quarried along this northern section and is of good quality. Some of the Marcellus limestone also occurs here. South of this the Mauch Chunk strata form the crest of the ridge which, in Tuscarora township, was covered with Hamilton sandstone, and as usual the Mauch Chunk soils are poor. The southern valley, between Perry county and this township is narrow and hilly, with some limestone Salina shales and some good farming sections. The limy shales and limestone soils are especially adapted for raising wheat, corn, potatoes and clovers.

This county was the pioneer in peach growing in this State, and it seems with good success, and there is no reason why this industry should not be made a success at this time.

The prevailing varieties of original timber were chestnut oak, and chestnut, with an admixture of black oak, red oak, beech, birch and scrub pine on the hills and mountains, while on the lowlands and the limy shales and limestone, the white oak predominated, showing the different capacity of these soils.

SNYDER COUNTY

Snyder county was formed out of the southern half of Union county by Act of March 21, 1855. It contains 199,040 acres, of which 151,922 acres is land in farms, and of which 112,394 acres is improved farm land. 11,827 acres were planted with corn in 1909, yielding 402,936 bushels; 15,371 acres were sown with oats, yielding 326,393 bushels; 20,505 acres were sown with wheat, yielding 292,746 bushels; 1,292 acres were sown with buckwheat, yielding 13,430 bushels; 3,046 acres were sown with rye, yielding 32,669 bushels; 2,162 acres were planted with potatoes, yielding 136,380 bushels; 21,136 acres were

sown with all forage crops, yielding 20,051 tons of the various kinds of hay. Of the 112,394 acres of improved farm land, 75,339 were used for raising farm crops, while 37,055 were not so used and were likely producing weeds. At this time the county has a population of 16,800 to feed, 10,364 cattle, 4,858 horses, 305 mules, 8,572 swine and 699 sheep.

Snyder county lies south of Union, north and east of Juniata and west of the Susquehanna River. The rock strata outcropping from which the soils of this county are formed, range from the Chemung shales and sandstone in the northern and southern part of the county down to the Hudson River slate and shales on Shade Mountain in the southwestern section. The drainage of the county is accomplished by Penns Creek and its tributaries in the northern part, Middle Creek and its tributaries in the central part and Mahantango Creek and its tributaries in the southern part, together with smaller streams along the Susquehanna River. The elevation of the county range from about 2,200 feet above tide, on Shade Mountain to 450 above, along the Susquehanna River.

Chapman, Perry and southern Washington townships occupy the southeastern corner of this county and have soils formed largely of very similar underlying rock strata.

CHAPMAN TOWNSHIP

In the southeastern corner of this township the Lower Helderberg and the Oriskany sand are brought up and form a fertile valley about two miles in length, entirely different from the soils further northward. The Marcellus black slate, a valley maker, because of it being softer and more readily disintegrated, comes up north of this limestone formation and assists in the formation of the soil, both of the more fertile limestone section as well as along Mahantango Creek further west beyond the limestone. Further north the Hamilton sandstone makes ripples in the river and forms a ridge and hilly country on the land, not by any means as fertile as further south. The Genesee, another of the easily disintegrated formations, is not well represented here or is well nigh completely concealed, while the harder Chemungs, which form a hilly, difficult to farm and not fertile section, are very prominent.

The Catskill red shales, the highest geological strata in this county, remain in a triangular shape extending along the river for a distance of about two miles and westward into the township for a distance of about three miles. The soils formed from these strata are stony and some extremely rough, while there the softer and more shaly formations occur gravelly and loamy soils of good fertility are

produced. This should be an apple raising section in this county. North of this Catskill formation, the Chemungs form a high ridge along the northern boundary line of the township with thin soils.

Perry township lies west of Chapman. The rock strata are the same as those of Chapman, except for a short distance in the northern part, the Upper Salina, the Lower Salina, the Clinton shale, and the Medina white sandstone come in on the southern slope of Shade Mountain. As already indicated, the softer Marcellus shales form the soil along the valleys of both branches of Mahantango Creek on the south extending in some places a considerable distance away from these streams.

East and west of Meiserville, in Chapman and Perry townships, are some of the rolling uplands so characteristic of the Chemung formation. The soils are likely a mixture of Hamilton and Genesee and Chemung strata because some of them are loamy and more fertile than Chemungs usually are. Between Meiserville and Troutville are several ridges of the Chemung sandstone with all the Chemung features, and the ringing fragments of broken down rocks of the Portage formation, both of them producing poor soils. Several upland plains not as hilly occur throughout this formation until the south side ridge of Buckwheat Valley, formed of Hamilton sandstone is reached.

This valley is largely eroted down to the Marcellus shales which, among the lower strata, contain some limy formation, producing a more fertile soil than the Marcellus usually do. The Oriskany sand on the north is shaly and readily disintegrates, forming, with the Marcellus, a valley extending east and west of Freemont and between the two Oriskany sandstone ridges west of this town. The Lower Helderberg limestone north of the Oriskany and Marcellus Valley, makes a prominent ridge in which are located a number of quarries from which limestone has been quarried for a long time for burning lime, for agricultural and other purposes. This limestone ridge and the Upper Salina north of it form a very fertile valley, known as Heister's Valley which will be discussed in connection with Penn and Washington townships.

SOUTH WASHINGTON TOWNSHIP

The Chemung strata make a high ridge along the line between Chapman and this township, extending to Mahantango Creek. North of this high ridge of Chemungs, the Genesee shales very much more easily disintegrated than the Chemungs form Knight Valley and make a fertile soil very much richer than any Chemung soils. North of this Genesee Valley, the Hamilton sandstone form a prominent ridge of massive sandstone, producing a rough and stony soil. North

of this Hamilton Ridge the more easily disintegrated Marcellus shales, form a fertile valley between the Hamilton and Firestone Ridges. No better illustration is afforded anywhere in the State of the difference in fertility of soils formed from strata belonging to the same geological formation.

WASHINGTON TOWNSHIP

North of the Firestone Ridge is a fertile valley, with soils formed of Helderberg, Upper Salina, Lower Salina or Bloomsburg red shale and some Clinton shales. Along the south side of this valley the Helderberg limestone is quarried and burned into lime in a number of places. This valley is narrow, but equally as fertile as the Salina valleys anywhere in the State. Here are stony or gravelly soils, apparently made up entirely of stones and gravel, that will produce all agricultural crops well nigh equally well in wet or dry seasons which can be plowed or cultivated when they are so wet that all other soils would be badly damaged, without any injurious effects.

Fruit trees as well as all other trees will grow luxuriantly on these soils and will produce well. This same formation extends westward through Perry township. North of the Bloomsburg red shale come the iron ore outcrops of the Clinton formation, with an intermixture of limy shales, producing hilly country apparently well adapted for raising apples and peaches especially the latter. The growing of peaches it seems should be encouraged here. What is said here of Washington township, is true of the same formation in Perry, except that iron sandstone and ore ridges are more prominent in Washington.

PENN TOWNSHIP

Penn township lies east of Washington and Middle Creek and west of the Susquehanna River. Selinsgrove, the largest town in Snyder county, is located in this township.

The rock strata outcropping in this township range from the Clinton ore sandstone east of Middle Creek, up to a narrow belt of Catskill strata on the northern border of the township. The southeastern corner lies in the loop of Middle Creek. Here the hard Hamilton strata make a ridge, around which the stream flows into the softer Marcellus east of this formation along the river. The Oriskany, north of the Marcellus, is not well exposed here, but the Lower Helderberg limestone, form a ridge which is covered with soil of considerable depth. From Selinsgrove west to the river and south along Middle Creek, the country is covered with alluvium brought down by the creek and the river. These soils are especially adapted for trucking and dairying because of their fertility and should be used for this kind of farming. This valley formed upon the Upper

Salinas extends northward to the ridge of the Lower Helderberg limestone and westward to the outcrop of the Lower Salina or Bloomsburg red shale west of Selinsgrove. This red shale outcrop is the eastern extremity of Shade Mountain. The soil is fertile and well adapted for raising all agricultural products especially the more completely disintegrated sections, along the Lower Salinas and along Middle Creek.

The Lower Helderberg, as already stated, forms a ridge along the northern extremity of this valley, the disintegrated rock of which has entered into the formation of the soils, the salient effects of which are very obvious. Here are some excellent outcroppings of the Bossardville limestone which have been quarried along this ridge for many years for agricultural purposes.

The part of this township north of this limestone ridge will be discussed in connection with the same formations in Monroe, Jackson, Middle Creek, Center, Franklin, Adams, Beaver, Spring and West Beaver townships. The Upper Salina formation of Penn township extend westward in a valley of considerable width through Middle Creek, Franklin, Beaver, Spring and West Beaver townships to the western limit of the county, known as Middle Creek Valley.

To the south of this valley, beginning with the outcrop of the Lower Salina or Bloomsburg red shale, west of Selinsgrove and running parallel with the valley, these shales form a ridge of varying height of red soil in many sections of splendid fertility, especially adapted to raising peaches according to the best tradition of those who do now and who have in years just past raised this fruit along the northern ridge of Bloomsburg, Clinton iron sandstone and shale.

In Middle Creek township, two parallel ranges of hills begin some distance west of Middle Creek. The one overlooking the valley is formed of an ore sandstone and the one to the south by the iron sandstone. These formations have resisted disintegration and, therefore, are hilly country. These same formations extend through Franklin township as far west as Spring township. In this western extremity the hills are steeper and rougher. In Franklin township, the Middle Creek Valley is wider and therefore contains a larger acreage of fertile farming land. It retains about the same width in Beaver township.

Parallel with Iron and Sandstone Ridge, above referred to, runs an upland Clinton shale formation having some farming soils that seem fertile and seem to be well supplied with water. These soils are sandy, gravelly, stony and some rocky. It seems that potatoes should do well here. In Spring and West Beaver townships the Middle Creek Valley becomes narrower, but the same rock strata are the basis of its soil, which are gravelly and sometimes stony, but fertile, especially the gravelly formations.

Before discussing the sections of the various townships lying north of the Middle Creek Valley, a short dscussion of West Perry township will be given. This township lies south of Beaver, Spring and West of Beaver, largely on the southern slope of Shade Mountain. The rock strata from which the soils of this township are formed extend from the Hudson River slate and shales on the Spiegelmyer Valley on Shade Mountain up to the Hamilton slates on the southeastern section of the township. The southern slope of Shade Mountain is rough and stony down to and south of the ore sandstone ridge which runs parallel with the crest of this mountain. South of this ore sandstone ridge the Bloomsburg red shale forms a red soil which, in many sections, mingles with the Upper Salina formation which parallels it to the south. These two, together with the Lower Helderberg limestone, form a broad, fertile valley west of Fremont along the southern border and partly through the center of which the Lower Helderberg limestone form outcrops from which limestone has been quarried and lime burned for agricultural purposes for many years. South of the limestone is Fire Stone Ridge, made of gravel and sand. Wherever this flint gravel is mixed with disintegrated limestone and sand, soils of splendid fertility are formed capable of producing crops in wet or dry seasons.

South of Fire Stone Ridge, Buckwheat Valley, already referred to, comes in from Perry township with soils formed of the Marcellus black and limy shales capable of producing all agricultural crops successfully. The townships and parts of townships lying to the north of Middle Creek Valley and including part of the valley extending westward from the Susquehanna River through New Berlin, Centerville and Troxelville to the western boundary of the township will now be discussed.

MONROE TOWNSHIP

Monroe township lies between the Susquehanna River on the east and Penns Creek on the west. The Catskill red sandstones, the highest rock strata geologically in this county, occupy a section approximately in the center of this township about two miles wide running east and west forming a moderately rolling upland country with soils of good fertility, the more gravelly adapted for apples, and such crops as rye, buckwheat, wheat and clovers, and the loamy for growing the hay grasses, corn and oats. North and south of this Catskill formation the Chemung strata form the underlying rock and produce hilly country not easily farmed.

The harder Hamilton strata further south form the Shamokin, falls in the river, and a series of hills westward through the township, while the Marcellus, Oriskany and the Lower Helderberg lime-

stone though covered over with debris have, on account of being more readily disintegrated, made it possible for the fertile southern section of this township to be formed, the soils of which will grow all agricultural crops. North and West of this formation the Marcellus shales evidently underlie the country, though they are not exposed, the existence of the valley land with intermixture of shales is sufficient evidence. West of Penns Creek in Penn township the Lower Helderberg limestone and the Oriskany sandstone make a prominent ridge. North of this ridge the country is very similar to that of Monroe township to the northern township line.

JACKSON TOWNSHIP

Jackson township lies west of Monroe along the Union county line, which is here made by Penns Creek. This creek flows on the Lower Helderberg limestone formation, along which the Marcellus seems to form the basis of the soil. The strata which produces so hilly a country in Monroe township, here make a moderately rolling one with less stony and more gravelly and loamy soils of better quality. The Catskill soil is similar here to that of Monroe.

CENTER TOWNSHIP

Center township lies west of Jackson, along the Union county line. The northern part of this township is exceedingly rough with little farming land. South of the ore ridge which parallels the mountain crest, the Clinton shale forms a strip of hilly farming land of fair fertility. The Bloomsburg red shale and the Upper Salina overlying it make a valley of fertile land running east and west through this township. On the south side of this valley the Helderberg limestone outcrops at a number of places, but does not form ridges of sufficient height for the easy quarrying of the stone. To the south of this limestone formation the Marcellus shales outcrop and enter the soil formation producing some fairly good soils; while still further south the Chemung and Catskill strata mingle and form a hilly country.

ADAMS TOWNSHIP

Adams township lies to the west of Center, with the same geological strata as Center, with the exception that the Catskill and about all the Chemung have disappeared with a probable small section along the eastern line of the township. The right branch of Middle Creek flows in a Marcellus valley of moderately rolling country of good fertility. The Lower Helderberg limestone outcrops in a ridge along this township and affords places for quarrying the stone.

The Upper Salina, because of a double bend in the rock, forms a wider valley than further east or west and, therefore, a larger acreage of fertile land especially in the vicinity of Troxelville. Northward from this town, the land is extremely rough until the top of Jacks Mountain is reached, upon which there is a rolling formation of considerable extent with sandy soil apparently of fair fertility.

SPRING AND WEST BEAVER TOWNSHIPS

The farming land of these two townships is confined to the Salina shale valley on the north of both townships, to the intermixture of the Lower Helderberg limestone, and these Salina shales and the cherty Oriskany sandstone and to the Marcellus shales. Skirting these sand and limestone formations, and to the Marcellus and Genesee valleys between the Hamilton ridges and hills to the south of the Marcellus valley, skirting the limestone as well as to the Middle Creek Valley extending westward from Beavertown already discussed. This section has some splendid farming land adapted to raising all agricultural crops as well as raising apples and peaches.

UNION COUNTY

Union county was erected out of Northumberland by the Act of March 22, 1813. It contains 195,200 acres, of which 108,790 acres is land in farms, and of which 86,973 is improved farm land. 14,308 acres were planted with corn in 1909, yielding 346,750 bushels; 13,604 acres were sown with oats yielding 335,206 bushels; 18,398 acres were sown with wheat, yielding 295,023 bushels; 208 acres were sown with buckwheat, yielding 2,017 bushels; 1,075 acres were sown with rye, yielding 12,939 bushels; 1,470 acres were planted with potatoes, yielding 97,101 bushels; 3 acres were planted with tobacco, yielding 2,500 pounds; 23,328 acres were sown with all forage crops, yielding 28,772 tons of the various kinds of hay. Of the 86,973 acres of improved farm land, 72,394 were used for raising farm crops, while 14,579 were not so used and were likely producing weeds. At this time the county had a population of 16,249 to feed, 11,072 cattle, 4,235 horses, 190 mules, 8,362 swine and 1,061 sheep.

This county lies west of Northumberland on the west side of the West Branch of the Susquehanna River. The outcropping rock strata from which the soils of the county are formed, begin with the Hudson River slate and shale No. 3 and extends upward to the Catskill red sandstone and shale No. 9.

The drainage of the county is accomplished by the Susquehanna River and its tributaries. Deer Hole Creek and White Deer Creek drain the northern part of the county, Buffalo Creek drains the Buffalo Valley, Turtle Creek a section south of Lewisburg and Penns Creek the western part of the county until it reaches Centerville. From this place it forms a line between Union and Snyder counties and its northern tributaries drain the southern part of Union.

GREGG TOWNSHIP

Gregg township projects into Lycoming and occupies the northern extremity of the county. The outcroping rock strata extends from the Medina sandstone which forms the crest of White Deer Mountain and also the southern boundary line of the township up to the Marcellus and Hamilton shales in the northern part of the township. The Clinton shales extend Westward from White Deer Mountain to the river continuing the ridge as the iron ore sandstone which, in its northward extension, brings to the surface the limy shales of the Clinton strata which always, unless interfered with by other formations, make a fertile soil. Here the ore knobs and sandstone interfere, but still such a combination with the sandstone, limy shales and iron ores is formed that a soil of splendid adaptibility for peach growing seems to have been formed. North of these ore knobs the Lower Salina or Bloomsburg red shale outcrop in characteristic color and fertility. These red strata intermingle here with the Upper Salina which form a valley ranging from a mile wide along the river to two miles wide along the Lycoming county line on the west and forming one of the most fertile agricultural sections of the county, with sufficient lime in its underlying strata to supply the needs of the soil for all time.

The Lower Helderberg runs parallel with this limy shale formation on the north and outcrops sufficiently to be quarried easily. Lime has been burned along this outcrop for a long time and sufficient remains to furnish all the lime needed throughout this section.

The Oriskany sandstone is poorly exposed and takes little part in the formation of the soil. The Marcellus and Hamilton shales are covered with drift material and boulders of Pocono and Catskill sandstone which forms terraces along the river, in some places 400 feet above the river bed. The soils are likely better because of the deposition of this drift material.

WHITE DEER TOWNSHIP

This township lies south of Gregg, and like Gregg, having the Susquehanna River for its eastern boundary. The rock strata in this township range from the Oneida sandstone up to the upper Salina lime shales. In the southeastern corner of the township the Salina

lime shales crop out and these, together with the Bloomsburg red shale and the Clinton, form the soils, which are fertile. Along the river are some of the best trucking soils to be found anywhere. Northward at New Columbia the soil, composed of drift materials and the underlying Clinton shale which outcrops in a number of places, is fertile. This formation extends westward to Buffalo Mountain where the Oneida sand stone outcrops and where little farming land exists and little farming is done.

North of this Clinton formation, the Upper Salina extends from the river westward between the curve produced by Buffalo and Nittany mountains for a distance of about six miles and forms a narrow section of very fertile soil. North of this Salina formation the Clinton shales and the iron sandstone, which forms a ridge, form the soil which is fertile and adapted to all agricultural crops.

At White Deer Station and northward the land is fertile, easily farmed and adapted to all agricultural crops. The formations enumerated extend westward, especially the Clinton shale, to Nittany Mountain which projects halfway eastward into the township. At Forrestville, along the White Deer Turnpike, and westward to the western border of this township, is a valley of Clinton shales along White Deer Creek of good fertility. Along Spruce Run, in the southern part of the township, is a similar valley of equal fertility. Nittany Mountain projects into the township and the sandstone and shales form a very rough section adapted only to forests.

KELLY TOWNSHIP

Kelly township lies directly south of White Deer. The rock strata exposed in this township range between the Upper Clintons and the Marcellus and Hamiltons, the former opposite Milton and the latter at Lewisburg. Along the road northward from Lewisburg the Marcellus black shales are exposed at a number of places until the Oriskany sand stone, which is soft and shaly, is reached. From this sandy formation rises a ridge of Lower Helderberg limestone, a continuation of Limestone Ridge in Northumberland county. These soils are fertile and adapted to all agricultural plants as well as market gardening and dairying. North of this ridge the Upper Salina, interspersed with thin beds of limestone, forms a valley of great fertility, running through the entire township. North of this valley the Bloomsburg red shale forms two distinct low ridges of lime containing strata between which a narrow Clinton shale formation outcrops. The Upper Salina again appears along the northern line of the township, but is followed in the northwestern corner by the Lower Salina and the Clinton.

The former extends from Spruce Run and Buffalo Creek on the north to Limestone Ridge and Shamokin Mountain on the south and east to the river. The rock strata outcropping in these two townships extend from the Marcellus black slates down to the Medina sand stone on Buffalo in the northern and Shamokin Mountain on the southern border. Lewisburg, the county-seat is located on the line between these two townships.

Shamokin Mountain, as already stated, forms the southern boundary of East Buffalo township of this Ridge, the Medina sandstone forms the crest and produces a rough, rocky and stony soil in the southwestern corner of the township. Going eastward toward the river, these sandstones sink beneath the Clinton shale and the land becomes adapted to farming. Along the river at Turtleville and west and south of this place is a ridge of iron ore and iron sandstone which it seems, together with the Clinton shale, should form a splendid peach soil adapted to producing a superior type of peaches which according to reports, was done here in the past. Northward along the river the Lower Salina forms a red soil of superior character capable of producing agricultural crops without soil amendments for a long time. What has been said about Shamokin Mountain in East Buffalo township is true of it in Buffalo township.

North of this mountain is the famous Buffalo Valley, one of the most fertile farming districts of the State, the soils of which are formed from the disintegrated Salina shales which always contain thin limestone veins and which frequently thicken to such an extent that they can be quarried and lime burned of them. Wherever these limestone strata are close to the surface and have disintegrated or are in the process of disintegration, deep plowing, and thorough cultivation will be the only operations necessary to obtain sufficient lime for all purposes. West of Lewisburg, in Buffalo township, the Lower Helderberg limestone is quarried for making lime.

The Mifflinburg Ridge is another outcrop of the Lower Helderberg limestone extending into Buffalo township south of Mifflinburg. In its eastern extremity it is entirely composed of limestone and has been burned into lime for many years. The Bloomsburg red shale on the Lower Salina, outcrops in two sections along the western border of this township and produces the characteristic red soils of good fertility. North of this, along Armstrong Run, the Upper Salina forms the soils, and further north to the township line the Buffalo Mountain strata, already described in connection with Kelly township, occupy the surface and make soils adapted largely for forest growth.

The former extends from Mifflinburg Ridge northward between Buffalo and White Deer on the east and Lewis township on the west to the Lycoming county line on the north; the latter from Mifflinburg Ridge southward to the Snyder county line. The geological strata of West Buffalo range from the Hudson River slates, which outcrop on Nittany Mountain, to the Lower Helderberg limestone on Mifflinburg Ridge on the southern border.

The southern portion of this township is in the famous Buffalo Valley, already referred to in the discussion of Buffalo and East Buffalo townships. It extends from Buffalo Ridge northward for a distance of probably two miles and is equally as fertile as the parts already described. The Bloomsburg red shale comes up north of this Salina valley and makes a section of intensely red soils in the eastern part of the township about a half mile wide while in the central and western part of the township the Clinton shales and the iron sandstone and along the border of these the Bloomsburg, mingle in the formation of the soils well adapted to fruit growing as well as potatoes and grains.

Similar soil formations, including a narrow strip of Upper Salina from Cowan to the western border of the township, occur northward to the town of Forest Hill which is situated on an outcrop of Bloomsburg red shale. From this place to the northern boundary of the township the Clinton shales, the Medina white and red sandstone, the Oneida sand and a narrow section of Hudson River shale form the underlying rock strata, producing some valleys of rather stony and rough, but fairly fertile soils well adapted for raising potatoes, buckwheat, corn, hard red wheat, oats and of fruits, apples and peaches. The outcropping rock strata of Limestone township range from the Oriskany sandstone on Mifflinburg Ridge to the Medina red sand stone on Jacks Mountain.

New Berlin, the first county seat of Union county, is located in the southeastern corner of this township. Penns Creek forms the boundary line between Union and Snyder county along here.

The Lewistown limestone ridge, coming in from Union township, forms an outcrop in this section of the township. South of this the Oriskany sandstone, composed of shale and sand, is so disintegrated as to be scarcely visible. The Upper Salina is confined to a comparatively narrow but still a very fertile valley which partakes of all the good qualities of the Salinas, while the Bloomsburg red shale on the Lower Salina is easily seen along the valley to the north forming a red soil. The Clinton limy shales occur along this mountain and produce a soil strangely fertile and productive.

Between Shamokin and Jacks Run, along Sweitzers Run, the Clinton shales occupy the surface as far west as Penns Creek and produce some agricultural soils of good fertility. On the north

side of this mountain the Bloomsburg red shale outcrops east and west of White Spring in this township and gives rise to soils that should be especially adapted to potato growing with a rotation of potatoes, wheat and clovers. North of these Lower Salinas come the Upper Salina on part of the Buffalo Valley equal in fertility to the parts already described. On the northern boundary of this township is the Mifflinburg Ridge of Lower Helderberg limestone and Oriskany sand, 7 miles in length capable of furnishing an immense quantity of limestone.

LEWIS AND HARTLEY TOWNSHIPS

Lewis and Hartley townships have soils very similar in formation. The crest of Jacks Mountain forms the southern boundary of both townships. The Oneida grey and the Medina red and white sandstone outcrop and form the crest of this mountain producing little or no farming land. North of the Medina white sandstone, the Clinton shale occupies the surface, which is rough and in many places steep. Clinton is followed by the Bloomsburg red shale which makes a distinct outcrop and enters the formation of the soils. North of the Bloomsburg come the Upper Salina, in the western extension of Buffalo Valley, producing a soil as fertile as that of the township previously described. North in this Salina valley, at Hortleton, is a narrow strip of Bloomsburg or Lower Salina, then comes the Clinton, again the same as the formation south of the Upper Salina Valley producing a more rolling formation than at the south and a more easily cultivated soil. North of the Clinton soils the following mountains enter and cross the township: Little Buffalo Mountain, Jones Mountain, Shriners Mountain, Seven Notch Mountain, Sand Mountain, Nittany Mountain and on the northern border White Deer Mountain.

With such an array of mountains formed of the Oneida grey sandstone and conglomerate and the Medina red and white sandstone, it is evident to all who are acquainted with these formations, that there is little easily farmed, farming soil in this section. But with all their roughness, these formations are capable of growing apple trees luxuriantly and producing a highly colored, well developed fruit. Beside, there are splendid potato, buckwheat, and rye soils in many parts of these mountains.

Hartley township has exactly the same geological strata in this northern section as Lewis. In it is also the western extremity of Buffalo Valley formed of the Upper Salina shales. The Lower Salina or Bloomsburg red shale comes up east of Laurelton and begins a ridge which extends westward. North and south of this ridge the limy shales continue to make a considerable valley along

Penns Creek to Jacks Mountain on the south. In this part of the township there is little farming land in fact all of it should be forested

THE BUFFALO VALLEY

This valley is one of the best adapted intensive farming districts in the State especially for the various phases of the livestock industry.

UNION TOWNSHIP

Union township occupies the southeastern corner of this county. It has the Susquehanna River for its eastern boundary, Snyder county for its southern, joins Limestone township on the west and east, and Buffalo on the north.

The rock strata outcropping in this township range from the Medina sandstone on Shamokin up to the Chemungs, which form the Ridge south of the Salina Valley. The Chemung strata as usual form a ridge of undulating shaly hills composed of stony, gravelly, sandy and loamy soils; in the valleys some clay. The upland loams and gravels adapted to potato, Baldwin apples, rye, oats, and wheat raising, and the lowland loams and clays for grass, corn, wheat and oats.

North of the Chemung Ridge comes a disintegrated Oriskany sand formation followed by the Helderberg limestone which has been extensively quarried in this township for burning lime for all purposes for a number of years. North of this limestone ridge the Upper Salina, and still further north the Lower Salina enter into the formation of the soil, and together, with the intermixing of some Clinton shale, these strata produce a narrow strip of fertile farming land. The Shamokin Mountain occupies the northwestern corner of this township with little farming land.

PERRY COUNTY

The Act of March 22, 1820, erected a new county out of all that part of Cumberland county north of the summit of the Blue Mountain and south of the Tuscarora and named it Perry. It contains 360,960 acres, of which 250,118 acres is land in farms, and of which 146,921 acres is improved farm land. 22,819 acres were planted with corn in 1909, yielding 546,806 bushels; 18,292 acres were sown with oats, yielding 422,573 bushels; 23,901 acres were sown with wheat, yielding 364,288 bushels; 1,235 acres were sown with buckwheat, yielding 13,183 bushels; 2,798 acres were sown with rye, yielding 30,118 bushels; 1,714 acres were planted with potatoes,

yielding 109,665 bushels; 1 acre was planted with tobacco, yielding 1,205 pounds; 30,270 acres were sown with all forage crops, yielding 32,185 tons of the various kinds of hay. Of the 146,921 acres of improved farm land, 101,030 acres were used for raising farm crops, while 45,891 acres were not so used and were likely producing weeds. At this time Perry county had a population of 24,136 to feed, 14,669 cattle, 5,584 horses, 946 mules, 10,725 swine and 4,275 sheep.

Perry county lies north of Cumberland, north and east of Franklin, south of Juniata, the greater part on the west bank of the Susquehanna River. The soils of the county, leaving out of consideration the trap dykes, are derived from eighteen, differing sufficiently to be separately classified, geological strata.

The strata begin with the Trenton limestone, which outcrops in Horse Valley, and extends through the Utica shale, the Hudson River shale, the Medina and Oneida sandstone, the Clinton shale, the Onondago grey and red shale, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus black shale, limestone and ore beds, the Hamilton lower shale, the Hamilton sandstone, the Hamilton upper shale, the Genesee shale, the Portage shale, the Chemung olive shale, the Catskill red sandstone and shale, the Pocono grey sandstone and the Mauch Chunk red shale. All these, together with the narrow trap dykes, enter into the composition of the soils throughout the various townships of the county.

The strata in this county represent, according to Prof. Lesley, 2nd Pa. Geo. Survey, F2, Page 36, a rock thickness of 32,725 feet.

TOBOYNE TOWNSHIP

This township occupies the southwestern corner of the county, with the Cumberland county line for its southern, the Franklin county line for its western and the Juniata county line for its northern boundaries. The rock strata from which the soils of this township are derived range from the base of the Utica shales, through the Hudson River, the Medina sandstone, the Clinton group into the Lower Helderberg limestone.

Horse Valley, in the northwestern corner of the township, contains the Utica and Hudson River shales which, together with the Medina sandstone of the mountains on both sides of the valley form the soils along these mountain sides facing the valley, which, in most cases, are stony and rough. But wherever the softer sandstone prevails the soils are deep with fairly large water and fertility holding capacity adapted to raising the cereals, grains and the clovers. Through the central part of this valley the land is not as hilly and less stony, with areas of considerable extent having deep soils which can be easily farmed and are productive and will produce the cereal grains and the clovers and are, therefore, adapted for

raising the crops to winter over animals that can be pastured during the summer throughout the vast mountain districts which cover the greater part of the remainder of this township.

These mountain districts cover the entire western part of this township, beginning with the Tuscarora Mountain, north of Horse Valley; followed by Conecocheque Mountain on the south side of the valley; and by Round Top, Little Round Top, Rising Mountain, Amberson's Mountain, Bowers Mountain, and ending with the Blue Mountain which forms the boundary line between Perry and Cumberland counties on the south, with soils derived of the Medina sandstone of little agricultural value. Between these mountains are more or less narrow and steep sided valleys, some of which contain agricultural soils. In the valley of Sherman's Creek, west of Fairview along the foothills of Round Top, are such soils.

Little Illinois Valley, between Rising and Amberson's Mountains, contains the most fertile soils of any of these valleys, derived from the limy strata of the Clinton formation. This limestone is sufficiently pure to be burned into lime for agricultural purposes. The soil in the valley between Amberson's and Bowers mountains is also derived from the Clinton shale; but these strata evidently do not contain as rich limestone veins. The same is true of Henry Valley, between Bowers and Blue Mountain. It seems that wherever possible, the agricultural soils of these valleys, which are adapted for raising the cereals, such as corn, oats, rye and barley, and among the clovers, Canada field peas, soja beans, cowpeas for both grain and roughage and alfalfa for hay, should be utilized for this purpose to finish beef animals during the winter which have been pastured during the summer on the mountains. While this may not be a very lucrative business, it seems that with a fair quantity of pasture and an ample supply of water and therefore the small amount of work required it should be sufficiently inviting to make the effort at least.

Further northeastward the valleys widen, the land becomes less steeply hilly, the soils deeper, more fertile and adapted to raising all the agricultural crops.

JACKSON TOWNSHIP

This township, like Toboyne, extends across the entire county and, therefore, has the Juniata county line on Tuscarora Mountain for its northern and the Cumberland county line on Blue Mountain for its southern boundary. Horse Valley, the soils of which are described in connection with Toboyne township, passes through the northern part of and ends in this township. South of Conecocheque Mountain and extending across the central part of the township, is an open valley containing, in such places as the vicinity of Blain, considerable areas of the most fertile land in the county with deep well disin-

tegrated soils naturally very fertile with large water and fertility holding capacity derived, except on the higher slopes of Conecocheque and Bowers Mountains from the Clinton and Onondago shales and the Lower Helderberg limestone adapted, the more fertile, to the most highly developed, intensive farming that can be practiced under prevailing climatic conditions.

At Blain, and north and south of this place, the Lower Helderberg limestone forms a ridge, on both sides of which, but especially on the east side, are among the most fertile limestone soils, derived from the Helderberg limestone anywhere in the State adapted to raising all agricultural crops that can thrive under prevailing climatic conditions; but especially adapted to livestock and dairy farming. Every two acres of this land will produce roughage and grain to feed one cow.

West of this ridge the Clinton and Onondago shale form a valley with limy soils that will produce large yields of a high milling quality, hard red wheat. These soils will also produce potatoes and clovers and, therefore, a rotation of clovers, potatoes and wheat, if the market for potatoes is such as to make the raising of this crop an inviting proposition, could be made to pay, especially if the wheat was sold for seed wheat for the raising of a high type of which this section seems to be especially adapted.

East of Blain and east of the limestone formation, the soils are derived from the same underlying rock, the Clinton, as those along the west but it seems are less limy and, except where the deep gravelly soils exist, do not produce as large yields of the hard red wheat as do the soils west of the limestone formation. The intermingling of the Medina sandstone in the soil along the western valley might account for this. With good agricultural practices such as the application of manure as it is made, the raising of soil improving crops whenever possible, will make these soils produce beyond present indications. These soils need only light applications of lime, except the bottom lands, which are largely clays. Here as much as fifty bushels per acre can be applied without injury. On Chestnut Ridge, which passes through this valley, the iron sandstone of the Clinton strata remains and forms a sandy, rather stony, thin soil with small water and fertility holding capacity.

This soil, as well as the more gravelly of the smaller ridges through the valley, can be worked earlier in the spring than the clay soils and crops such as rye, winter wheat and early seeded spring crops such as oats and Canada field peas can be grown for hay before the hot and dry weather of summer sets in and when this weather comes, a dry weather crop such as cowpeas can be started.

Bowers Mountain, of Medina and Oneida sandstone, passes through this township and rises about 2,000 feet above sea level. Along both slopes of this mountain are some fairly deep and fertile soils derived from the Clinton shales and the softer red sandstone with comparatively good water and fertility holding capacity, adapted for raising such crops as buckwheat, rye, oats and the clovers. East of Bowers Mountain and between it and Blue Mountain, Henry's Valley carved out of the Clinton shales, continues as Shaeffer's Valley, with rough soils along the sides of the mountains and smoother and less stony soils through the center of the valley adapted for raising such crops as the cereal grains and the clovers.

MADISON TOWNSHIP

Madison township lies east of Jackson and extends from the Tuscarora Mountain, which forms the boundary between it and Juniata county, to the Blue Mountain on the south which forms the boundary between it and Cumberland county. The strata from which the soils are derived are the same as those of Jackson township, except that the Marcellus lime shales and limestone enter the township from Sandy Hill. Liberty Valley lies between Conecocheque and Tuscarora Mountain along the northern border of the township containing fertile soils derived from the limy shales of the Clinton formation, adapted to raising the cereal grains, especially wheat of which it produces large yields of a hard red, high milling quality. These soils, like those referred to in Jackson township, should be devoted to raising seed wheat and clover seed, which can be equally well produced here. Alfalfa can be successfully raised on the deeper soils of this valley. A rotation of alfalfa followed with corn, the corn with Canada field peas and oats, the oats with rye and winter vetch or wheat and then back to alfalfa would make a splendid combination.

A valley with soils derived from the same limy Clinton strata runs parallel with Conecocheque Mountain, referred to in the discussion of Jackson township, and which, therefore, needs no further comment here.

Center Valley is a moderately rolling section, the soils of which are derived from the disintegrated Lower Helderberg limestone, and like those in the vicinity of Blain, are among the most fertile in the county, adapted to raising all agricultural crops that will thrive under prevailing climatic conditions. This is one of the smaller sections of the State in which production could be very much increased by a rotation of crops with which it would be possible to raise a soil improving crop at the same time or after a soil exhausting crop has been raised. Soils having the natural fertility and the

water holding capacity that these soils have make it possible to produce one soil improving crop in connection with a crop for human nutrition.

The soils of Sherman's Valley, or the valley between Chestnut Ridge and Bowers Mountain, are derived from the Medina sandstone, debris from the mountains on both sides of the valley and from the Onondaga shales within the valley. These soils are usually stony and rough except in sections where some of the softer shales and sandstone occurs where they are deep, naturally fertile because of the limy strata which occurs in the rock from which they are derived, adapted to such crops as have previously been referred to.

A formation, the Marcellus, not previously referred, comes into this township from Saville and being composed of limestone and shaly strata, the soils derived from it are equally as fertile, in many places, as those derived from the limestone and are more easily farmed because they contain more gravel and loam and less clay than the limestone soils and can be cultivated earlier and crops be well started before the clay soils can be cultivated. The same mountain ranges having the same soils cross this township that cross Jackson and need no further discussion here.

TYRONE TOWNSHIP

This township lies east of Madison with its southern boundary following the curve of the crest of the Blue Mountain. This long, sinuous mountain, forming the southern border, is made of the Medina sandstone with only small areas of land adapted to farming. The land along the lower mountain sides is steeply hilly with soils derived from the Clinton shale, while the land of a large area in the central and western part of the township is moderately rolling, with deep soils derived from the Bloomsburg limy red shale, which is the reason why the soils of this township are generally fertile and very productive. The more loamy types of these soils are among the best corn and wheat lands in the county, producing large yields of a hard red, high milling wheat. Here is another seed wheat and clover seed section the soils of which should be cropped in such a way that the largest quantities of these seeds could be raised and at the same time the fertility of the land maintained and improved. In the deep and loamy soils of this township, alfalfa yields splendid crops and should be put into the rotation in this section, because the limy formations from which the soils are largely derived will keep the soil in the right condition for the continuous production of the crop.

The Lower Helderberg limestone comes into the township at four points, the first of which is Bells Hill; the second, the ridge opposite Landisburg; the third, the outcrop south of Landisburg; and the fourth, Limestone Ridge, the crest of which forms the northern boundary of the township.

This outcrop is long and narrow and the strip of soils derived from it, though limited, is fertile and very productive—similar to that in the vicinity of Blain.

SAVILLE TOWNSHIP

This township lies north of Tyrone, east of Madison, with the crest of Tuscarora Mountain forming the boundary between it and Juniata county. The strata from which the soils of this township are derived range from the Medina sandstone, on Tuscarora Mountain, up to the Catskill red sandstone along the eastern border of the township. Buffalo Valley lies in the northern part of this township. It has comparatively deep, fertile soils with fairly large water holding capacity and with large fertility holding capacity, derived from the Onondaga shales, adapted to the raising of the cereal grains, especially wheat of which it will produce large yields of a hard red, high milling quality. The clovers, such as the red, alsike, Mammoth and alfalfa, will also thrive in these soils and their production should be the aim of all farmers so as to increase the capacity for feeding livestock.

At Ickesburg and its vicinity, the Lower Helderberg limestone and the limy Marcellus shales, referred to in the discussion of Madison township, enter the formation of the soil and make deep fertile soils with large water and fertility holding capacity, adapted to raising all the regular agricultural crops, especially wheat, corn and the clovers—and among these latter—alfalfa. This section, like that about Blain, contains as rich farming land as occurs anywhere in the county, adapted to the most highly developed, intensive farming such as prevailing climatic conditions make possible.

This same formation of Lower Helderberg limestone and Marcellus shales runs along the southern part of the township, north of Loysville, where it forms limestone ridges and, as at Blain and Ickesburg, is and has been the source of the limestone for burning lime for agricultural purposes for a long time. The land, though more hilly than at Ickesburg, where it is mostly moderately rolling, is equally as fertile and adapted to raising the same crops. North and south of these fertile sections, running approximately through the central part of the township along the northern slope of the Raccoon Ridge, bordering the fertile formation, is quite an extensive undulating section. In the western part of the township on the

southern slope of Buffalo Mountain, the soils of which are derived from the sandy Marcellus shales and are thin, wash readily, and hard to keep in productive condition.

This land should be in forest continuously for ages until the soils are sufficiently deep with such water and fertility holding capacity that agricultural crops can be produced.

The soils of Middle Ridge are drived from the Chemung and Upper Hamilton strata, and while some rolling sections are more fertile naturally than the sandy and shaly slopes, previously referred to, they are not well adapted for the production of most of the regular agricultural crops, but will produce rye, buckwheat and timothy hay, but should largely remain in forest. In the vicinity of Roseberg are some low lands which should be underdrained to get the best returns.

TUSCARORA TOWNSHIP

This township has for its northern border the Juniata county line, extending from Saville township on the east to the Juniata River on the west. It is one of the most hilly and mountainous townships of Perry County, with its agricultural soils confined to the narrow valleys. The land in Raccoon, or the Northern Valley of the township is rolling, with fairly deep, fertile soils, with good water and splendid fertility holding capacity, derived from the intermingling of the Clinton and the Onondaga shales, the Lower Helderberg limestone and the Marcellus shales; a mixture that will make a fertile soil adapted to raising regular farm crops.

Buckwheat Valley is narrow, with soils derived from the Upper Hamilton shales, referred to in Saville township, and the Genesee and Portage, making soils that are poor in origin and consequently poor in action, but are still more fertile than the soils on the ridges surrounding the valleys. The Chemung shales make the basis of the soils on Hominy Ridge and are among the poorest in the county. The valley, between Tuscarora and Ore Ridge, though rough, has soils that will produce thrifty peach trees yielding large crops of well colored, nicely flavored fruit.

GREENWOOD TOWNSHIP

Greenwood township lies east of the Juniata River, with Turkey Ridge forming the boundary between it and Juniata county. This township is divided into two valleys: The northern or Pfousts Valley, lying between Turkey Ridge, and Wild Cat Ridge, while the southern or Wild Cat Valley lies between Wild Cat Ridge and Buffalo Mountain.

The land in Pfousts Valley is fertile, with deep, limy soils, having fairly large water and very large fertility holding capacity, derived from the limy Clinton shales and the Lower Helderberg limestone,

adapted to the raising of all the cereal grains, but especially wheat, of which it will produce large yields of a hard red, high milling quality. The red and alsike clovers and alfalfa will thrive here and produce large crops. Potatoes will also yield inviting returns. Clover, wheat and potatoes would be a rotation well adapted for this soil. Wild Cat Valley is broader throughout than Pfousts Valley; but one acre in Pfousts Valley is worth two in Wild Cat, especially is this true of the northern part of the valley, part of which is hilly, with thin soils, having small water and fertility holding capacity, derived from the Chemung shales, adapted for raising such crops as buckwheat and rye, and such poor soil clovers as the cowpea, and probably the sweet clover.

Wherever these soils are farmed, an effort should be made to introduce the sweet clover and the cowpea, both of these crops make a very nutritious hay. The soils of the southern part of this valley are derived from the Chemung and Catskill shales and are deeper, with larger water and fertility holding capacity, adapted to raising, among the cereal grains, wheat, oats and rye; and among the fruits, apples. The ridges have some farming land along their slopes, but usually of very poor quality and better adapted to growing forests than agricultural crops.

LIVERPOOL TOWNSHIP

This township occupies the northeastern corner of the county, with Juniata county for its northern and the Susquehanna River for its eastern boundary. The township it not as mountainous as Greenwood, because the underlying rock strata, which makes the mountains in Greenwood, are either absent or are more shaly, like the Hamilton Group, and consequently have yielded more to the agencies of disintegration which have proceeded further and have lowered the hills and mountains and have made a deeper and smoother soil (but by no means smooth), in Greenwood; while Pfousts Valley, in Liverpool, is more hilly and not as fertile as in Greenwood. The Catskill Valley, the soils of which are derived from the Catskill and in part from the Chemung Catskill, is wider and more fertile in Liverpool than in Greenwood and adapted for raising the same agricultural crops and among the fruits the apple.

JUNIATA TOWNSHIP

Juniata township lies south of Tuscarora, east of Saville and north of Center. The soils of the township are derived from two geological formations, the Chemung and Catskill. In the northern part of this township the soils are derived from the Chemung strata and are thin and lean, with small water and fertility holding capacity, adapted to forest growing and of little value as agricultural land. The soils throughout the central part of the township are

derived from the Catskill red shale and as usual, are fairly fertile and adapted to the raising of such crops as wheat, corn, oats, rye, buckwheat, timothy and red clover, and among the fruits, apples of which they will produce vigorous, disease resisting trees, which yield large crops of well developed, highly colored, nicely flavored fruit. Some sections on Middle Ridge have similar adaptations but are not as fertile.

OLIVER TOWNSHIP

This township lies east of Juniata, south of Tuscarora, with the Juniata River for its eastern boundary. Limestone Ridge, made up of the Lower Helderberg limestone, extends along the southern border of the township and here enters in a small way into the formation of the soil, but the land is hilly and difficult to farm and the limestone is more valuable as a source of lime than for the good it does in forming soils. The Buffalo Hills, paralleling Limestone Ridge on the north, are the most rugged formation in the township, made of the Hamilton sandstone, with poor, rough soils, of little agricultural value, but well adapted for raising timber. The central part of this township is within the more moderately rolling red Catskill formation, with fairly deep soils, with comparatively large water and fertility holding capacity, adapted to the same agricultural and fruit crops as the soils previously discussed derived from the same strata.

The banks along the river in this same formation in the northern part of the township are steep and come close to the water, while just above Newport the land along and away from the river becomes rolling and sections of some extent with alluvial soils occur along the river adapted to intensive farming.

CENTER, SPRING AND MILLER TOWNSHIPS

These three townships have soils largely derived from the same geological strata. Center township lies south of Juniata, in the central part of the county. New Bloomfield, the county seat of the county, is located in this township. Buffalo Hills, composed of the Hamilton sandstone, skirt the northern part of this township, with rough land and thin soils, poorly adapted for farming. Between these hills and Limestone Ridge, the softer Hamiltons form a valley, though rough and hilly, return profitable crops.

Limestone Ridge, made up of a number of smaller ridges of Lower Helderberg limestone, extends across the township in a northeastern and southwestern direction, with stony, and in some places, even rocky land, with usually deep, fertile soils, with large water and fertility holding capacity similar to and with similar adaptations to the limestone soils previously discussed.

The Onondaga shales enter, only, in a small way into the formation of the soils in this township, in the vicinity of New Bloomfield, and thence southwestward where these shales and the limestone combine in the composition of the soil. The Marcellus limestone also occurs in this vicinity and enters into the formation of the soil with similarly good effects as elsewhere. Mahonoy Ridge, the lower slopes of which have soils derived from the shaly Hamilton strata of some agricultural value, while the Hamilton sandstone on the higher elevations make soils of little agricultural value. Between Mahonoy Ridge and Iron Ridge, the crest of which forms the southern boundary of the township, is a wide valley with soils derived from the Chemung shales which are among the most fertile Chemung shale soils anywhere in the State, adapted to raising all the regular farm crops, more especially, however, to raising timothy hay, corn, potatoes and red clovers, and among the fruits, the Baldwin apple.

SPRING TOWNSHIP

Spring township lies south of Saville and Chester, east of Tyrone, with the Cumberland county line for its southern boundary. Blue Mountain forms its southern boundary with soil similar to those previously discussed in connection with townships further west. Mount Pisgah is the meeting point of Pisgah Hill and Little Mount, both ranges being formed by the hard Hamilton sandstone, the former extending northeastward along the Lower Helderberg limestone outcrop and the latter, along Pole Cat Valley in the southern part of the township. The soils of the western extremity of Pole Cat Valley and where it curves northward, are derived from the Onondaga limy shale, and in the western section of the Lower Helderberg limestone and are fairly deep with good water and large fertility holding capacity, adapted to raising the same crops as soils of similar derivations previously described. From Bridgeport, northeastward, is a second valley with soils of similar derivations, with similar adaptations. The same is true of the valley at Elliottsburg and vicinity with soils derived from similar strata.

The limestone, with which this township is amply supplied, is the basis of a considerable section of soils swinging in a semi-circular course from Iron Ridge to Elliottsburg, derived from these limestone strata of equal fertility and with similar adaptations as the limestone soils previously described. The Marcellus limestone also occurs here and, in a small way, takes part in the formation of the soil while the Marcellus shale forms the soils along the base of North Furnace Hill, Crawley Hill and Mahonoy Ridge which are similar in productive capacity and adapted to the same crops previously discussed. The hills, South Furnace, North Furnace and Crawley

hills and Mahonoy Ridge are formed of the Hamilton sandstone with little on farming land that yields inviting returns of agricultural products.

MILLER TOWNSHIP

Miller township lies in the curve of the Juniata River south of Oliver and east of Center. The soils of this township, as those previously discussed, are derived from the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus limestone and black shale, the Hamilton shale and sandstone and the Chemung and Catskill strata. Limestone Ridge, coming in from Oliver township, extends through this township, providing the township with a large quantity of this stone. The soils derived from these strata have similar capacities as those of the limestone soils previously discussed. The same is true of the Marcellus, the Hamilton, the Chemung, except that in a few sections along the river where alluvial soils derived from the materials brought down by the river and adapted to intensive farming.

WHEATFIELD, CARROLL AND RYE TOWNSHIPS

These townships have soils derived from the same geological strata, except the Onondaga formation in Carroll and Rye, which does not occur in Wheatfield. Wheatfield township lies south of Miller and Center, along the Juniata River. It is a long narrow township, with soils derived largely from the Chemung shales which are usually thin on the higher slopes and steep hillsides, with well rounded hills and with some deeper soils on the rolling upland and the wider valleys, with, however, limited natural fertility, water and fertility holding capacity, adapted the more fertile to raising timothy hay, potatoes and corn. It seems that such dry weather crops as Kaffir corn, among the cereal grains and cowpeas among the clovers, with a rotation adapted for raising these crops should produce inviting returns and at the same time improve the soil. The Chemung Catskill and the Catskill soils are similar in derivation and adaptation to the soils of this type previously described.

CARROLL TOWNSHIP

Carroll township lies east of Spring with the Cumberland county line for its southern boundary. Pole Cat Valley, previously referred to, passes through the southern part of this township with soils previously described. The Lower Helderberg limestone, previously discussed, outcrops along the northern border of this valley in sufficient quantity to furnish an ample supply of lime for this entire southeastern section of the county.

Little Mountain, also previously mentioned, extends through this township and forms the northern border of Pole Cat Valley, with soils derived from the Hamilton sandstone, of little agricultural value.

Between Little Mountain and Pisgah Hill, which forms the northern boundary of the county, lies and undulating valley, with soils derived from the olive shales, of the Chemung, and from the lower soft shales and sandstones of the Catskill strata, which yield rather readily to the agencies of disintegration on account of which a comparatively deep and fertile soil is formed adapted to raising wheat, corn, oats, the clovers, potatoes, and among the fruits, the apple. The soil of the Upper Catskill, lying along Cove Mountain and forming the ridge, are not as fertile and of little agricultural value.

Rye township occupies the southeastern corner of the county. Two valleys, the one along the southern border on the Onondaga shales and the other on the Catskill, extend through the township, with soils of similar derivation previously discussed. At Marysville, the undulating valley of the Catskill formation reaches the river. This valley contains some good wheat soils producing a high grade of the cereal.

PENN TOWNSHIP

This township lies north of Rye, east of Carroll, south of Wheatfield, along the Susquehanna River. The strata from which the soils of the township are derived range from the Catskill through the Pocono into the Mauch Chunk red shale. Much of this land is rough and stony especially along the slopes and crests of the two Pocono Hills and mountain ranges which traverse and come to a point in the southwestern part of this township.

The soils in the western and northern part of the township, derived from the Catskill red sandstone, are simlar in formation, adaptation as well as capacity. The land between the two mountain ranges, above referred to, is hilly along the mountains and of little value for agricultural purposes; while toward the central part of the Cove the land becomes more rolling with comparatively deep soils, with fair water and fertility holding capacity, containing sufficient lime to make good clover, wheat, potato and timothy soils. Blue grass also thrives in many places along the road side. Among the Mauch Chunk soils throughout the State, with the exception of those discussed in Fulton county and the Conyngham Valley in Luzerne county, are among the most fertile, adapted for raising all the agricultural crops, and among the fruits, the apple.

WATTS TOWNSHIP

This township occupies the point of land between the Susquehanna and the Juniata rivers. The soils along the streams and on the islands are derived from ancient river bottoms and alluvium, and

are fertile, adapted to dairying and other intensive farming and trucking. The soils are gravelly, sandy and loamy with large water and fairly good fertility holding capacity adapted, the more elevated, to the raising of corn, oats, wheat and the clovers and hay grasses; while the low, sandy types will, with careful handling, produce early truck crops as well as any in this part of the State.

The central part of the township is rolling and some of it hilly, with soils derived from the Catskill and Chemung shales of which the more rolling and level uplands are fairly deep adapted to the raising of timothy hay, oats, corn, wheat, rye and with liming, the clovers. These soils will also produce potatoes; but they are better adapted for apple raising and will yield larger returns than by raising the agricultural crops. The Hamilton and Chemung shales form ridges along Half Falls Hill with soils that are thin and poor, difficult to farm, yielding short crops, except where the soil is strong enough to raise Baldwin apples. The Lower Helderberg limestone crops out along the river in the northwestern corner of the township furnishing limestone for lime so essential in many of these soils.

BUFFALO AND HOWE TOWNSHIPS

These townships lie, the former, north of Watt's, with the Susquehanna River for its eastern boundary; the latter, west of the former, with the Juniata River for its western boundary. The soils are derived from the Hamilton, the Chemung, the Catskill red shale and the Mauch Chunk red shales. The Hamilton and Chemung Hills extend from the Juniata River eastward through Howe and Buffalo townships, making a section of poor, thin and unproductive soils. The Catskill sandstone and shale parallels this formation with land somewhat more rolling and more fertile, but hilly and difficult to farm, which will, however, produce thrifty apple trees, yielding fairly large crops of well developed, well colored, nicely flavored fruit.

The Pocono sandstone from Berry and Buffalo mountains, which come to a point in Howe township, the latter of which makes the boundary between Buffalo and Liverpool township and between Howe and Greenwood, makes soils of little agricultural value. The soils in the Cove, between the two mountains above referred to, are derived from the Mauch Chunk red shale and, while nearly the whole valley is affected by the rough country with which it is surrounded, the soils are more fertile than anywhere in the township adapted to raising buckwheat, oats, potatoes and with lime the clovers. Apple trees are thrifty and produce fair crops of well colored fruit. In the curve of the Juniata River, near Newport, is some rolling land of fair fertility which will produce large yields of timothy hay and

the hay grasses, and fair crops of corn, oats and wheat, but unless limed, these soils will usually not, unless climatic conditions are especially favorable, produce clovers.

The following analysis represent the composition of the Chemung limestone which outcrop in both Howe and Oliver townships, and wherever the outcrop takes part in the formation of the soil, it is made evident by the tree and crop growth. This stone could be ground and applied to the soils with good effect:

	I	II	III
Carbonate of lime,	60.214	49.178	33.482
Carbonate of magnesia,	1.664	1.816	1.967
Oxide of iron and alumina,	5.384	5.761	8.298
Phosphorus,	0.068	0.052	0.084
Siliceous matter,	31.520	41.940	53.810

2nd Geo. Survey Pa. F2, Page 224.

The county is drained by the Susquehanna River on the east, the Juniata and its tributaries flowing eastward in the west and south. The railroad facilities of the county are fairly good, but could be improved.

NORTHUMBERLAND COUNTY

Northumberland county was formed March 12, 1772. It contains 290,560 acres, of which 211,583 acres is farm land, and of which 164,470 acres is improved farm land. 24,793 acres were planted with corn in 1909, yielding 243,080 bushels; 22,775 acres were sown with oats, yielding 486,337 bushels; 26,401 acres were sown with wheat, yielding 435,639 bushels; 3,186 acres were sown with buckwheat, yielding 33,949 bushels; 5,976 acres were sown with rye, yielding 68,054 bushels; 4,395 acres were planted with potatoes, yielding 235,913 bushels; 15 acres were planted with tobacco, yielding 16,025 pounds; 32,246 acres were sown with all forage crops, yielding 34,160 tons of the various kinds of hay. Of the 164,470 acres of improved farm land, 119,727 acres were used for raising farm crops while 44,743 acres were not so used and were likely producing weeds. At this time Northumberland county had a population of 111,420 to feed, 14,383 cattle, 6,805 horses, 818 mules, 13,303 swine and 1,114 sheep.

This county borders the eastern bank of the West Branch of the Susquehanna River for a distance of twenty-two miles north of the town of Northumberland and twenty-one miles south of the same town. The rock strata outcropping in this county and which form the

basis of the soils, range from the Clinton shales to the coal measure rocks, including eleven geological formations. The North Branch of the Susquehanna River unites with the West Branch between Northumberland and Sunbury, the county-seat. These streams and their tributaries drain the entire county.

DELAWARE TOWNSHIP

This township occupies the northwestern part of the county, having Lycoming county for its northern and the West Branch of the Susquehanna River for its western border. The rock strata of the township begin with the Lower Chemung, in the northern part extend down to the lower Salina in the southern part. The Chemung formation in the northern part of the township rises from 300 to 400 feet above the Hamilton Valley to the south and makes a very hilly country similar to that of Montour and part of Columbia counties, described under those counties. These soils are especially adapted for potato raising, and will produce as highly colored and well flavored Baldwin apples as can be produced anywhere in the State. With moisture and nitrogen supplied by the use of manure or by the plowing down of clovers, it seems these hills could be made to yield profitable returns from apple growing.

The Hamilton strata south of the Chemung valley of about two miles in width extends from the eastern around to the northeastern end of the township. As this valley approaches the Susquehanna Valley, so much drift material has accumulated that a terrace has been produced rising and extending eastward in a moderately rolling plain for some distance into the township. This flooded river epoch material, or whatever other explanation for its existence may be offered, covers this whole section of the township and forms soils of Catskill, Pocono, Chemung and other transported materials. These soils are naturally productive. South of the underlying Hamilton strata, the Helderberg limestone enters the township from Lewis township to the east and passes out of it at the river line. Throughout this entire district the soils are fertile and adapted to all agricultural crops.

South of the limestone formation, the Oriskany sandstone forms a rather broad ridge of what seem to be, from what they produce and can be made to produce, the most fertile sandy soils anywhere in the State. These soils do not seem to become as dry as sandy soils usually do. South of this ridge the Salina red shales appear forming, where these are the largest component, entering the formation of the soil an easily cultivated productive soil with sufficient lime for all purposes. Where the Salina are not the largest component entering the formation of the soil this is not the case.

LEWIS TOWNSHIP

Lewis township lies directly east of Delaware and west of Montour county. The Chemung hills in this township, as in Delaware, rise from 500 to 600 feet above the Hamilton Valley. The Glades Valley (a local name) with moderately sloping hillsides, is one of the most fertile valleys in the Chemung formation anywhere in the State. Here disintegration has gone far enough to bring out all the better qualities of the Chemung strata.

The Hamilton south of the Chemung is similar to that already described in Delaware township, covered with material transported from other formations. These soils are productive. The lower meadows produce splendid hay corps and the higher elevations, the grains. The Lower Helderberg limestone crosses the township in a northwestern course entering it from Montour county. All along this ridge the soils are very fertile and some of the best so-called regular rotation crop farming in the State is done here and in the Salina Valley south of this.

This township differs in the soil from Delaware in that in Delaware the Lower Salina, or Bloomsburg red shales enter the formation of the soils, while in this township the Upper and Middle Salinas enter the formation especially in the southwestern corner of the township. The more shaly of these soils seem to be splendidly adapted to potato raising as well as the lime-loving cereal grains and the clovers.

TURBOT TOWNSHIP

Turbot township lies south of Delaware and Lewis and between the Susquehanna River and Montour county. In the northwestern part of this township the Lower Salina or Bloomsburg, already referred to in Delaware township, comes to the surface and enters the formation of the soils and produces a very persisting and productive soil which, with good agricultural treatment, should never be in need of lime or nitrogen. Between this northern section and the Milton Curve in the rock, the Middle and Upper Salinas remain and form a very desirable soil, one that should be especially adapted to raising wheat and potatoes.

The Lower Helderberg limestone ridge forms the southern boundary of this township the northern steep slope of which is formed by what is geologically known as the harder Bassordville limestone and the southern by the softer Cherty Oriskany sandstone; the northern slope, because of the presence of the harder rock, being steeper and the southern more gentle. Southern Delaware and Lewis and all of Turbot, in Northumberland county, and Limestone in Montour county form one of the rich agricultural districts of the State. These soils are sufficiently fertile for every two acres to support one cow each year or to furnish feed to grow and finish one steer every year.

These fertile sections of Pennsylvania should be devoted to producing the milk for our large cities because there is sufficient fertility in these soils to maintain them with a herd of cows that they will not become poorer but richer as time goes on.

CHILLISQUAQUE TOWNSHIP

Chillisquaque township lies directly south of Turbot along the Susquehanna River. It has for its northern boundary Limestone Ridge and for its southern Montour Ridge.

As previously stated in the discussion of Turbot township, the Oriskany sandstone makes the long south slope of Limestone Ridge along the northern boundary. This slope is strewn with the disintegrated materials of this formation which makes gravelly and sand soils that do not dry out as sandy soils usually do and will produce well though poorly farmed. Apple trees grow luxuriantly here.

South of this ridge the Hamilton strata occupy the surface and are largely the source of the soil. Pottsgrove is situated approximately in the central part of this valley and is surrounded with the Hamilton formation throughout the valley. Where the Hamilton shales come close to the surface the soil dries out easily and is not productive; but where clays have been formed the soil is usually wet and cold in the summer. All this is remedied by the introduction of organic matter into these soils. These clay soils will produce a sod when limed or manured, a stronger sod when both limed and manured. Advantage should be taken of this capacity to get the so essential organic matter into this soil. Timothy hay should be made one of the money crops on these clay soils. Rye and buckwheat are well adapted to the lighter of these Hamilton soils.

The Lower Helderberg limestone parallels the Hamiltons and crops out along the road east of Montandon. South of this formation the Salina makes a low ridge. The limestone has been quarried along this ridge and burned into lime. The soils in this section are fertile. South of this comes the Montour Ridge and the soils become rocky.

A considerable acreage is tillable and should be productive. Peaches are said to have been raised on these hills years ago.

POINT TOWNSHIP

Point township lies directly west of Chillisquaque and extends southward to the confluence of the North and West Branches of the Susquehanna River. The crest of Montour Ridge forms the northern boundary of the township. South of this ridge and running parallel with it is the Bloomsburg red, the Salina, the Lower Helderberg limestone (which has been quarried and burned into lime), and the

Oriskany and the Hamilton. These together form a valley rough and stony in some places, but of good fertility, adapted to cultivated crops, such as potatoes and corn. These soils do not wash, do not seem to become dry in dry weather nor too wet from abnormal rains. This valley is a continuation westward of the valley that crosses the river at Danville to South Danville, and then back to the north side of the river near Chulaskey Furnace. West of this place is a wide valley on the Hamilton, Lower Helderberg and the Salina rocks which represent the second river terrace at Northumberland. Here are some of the best market gardening soils in this State, made of sand and transported materials from numerous sources. Going westward in the township from where the wide valley reaches the river, the Chemung hills rise between it and the river and, as usual, change good conditions to conditions not so favorable. South of this are the river terraces, already referred to, resting on the Catskill and Chemungs.

UPPER AUGUSTA TOWNSHIP

Upper Augusta township lies south of the North Branch of the Susquehanna River at Sunbury, the county seat. The rock strata outcropping in this township extend from the Catskills down to the Salina. In the vicinity of Sunbury and east and south of this place, on the Hamilton formation, the soils are made of drift materials and are fairly fertile. Still further east along this same formation the county becomes moderately hilly with some good farming land. North of the Hamilton valley a narrow Chemung ridge separates it from the Catskills to the north. The Chemung soils are rough and hilly, while the Lower Catskills are more rolling, more fertile and more easily farmed though they too are stony.

RUSH TOWNSHIP

This township lies directly east of Upper Augusta, along the North Branch of the Susquehanna River. The formations are the same as Upper Augusta. At South Danville the curve in the river brings the Lower Helderberg and the Hamilton limestone south of the river, but these are covered with terrace deposits. This is the most fertile portion of this township, with soils especially adapted for market gardening and all regular farming operations.

South of this river formation the Chemungs which, with the Catskills, form a hilly country, with stony soils, difficult to farm, with here and there a relieving stretch of moderately rolling uplands and valleys with considerable width and moderately rolling hillsides are of well nigh unending occurrence.

SHAMOKIN TOWNSHIP

Shamokin township lies directly south of Rush. The northern boundary follows the Chemung ridge which forms steep slope down into the Hamilton valley along Shamokin Creek, along which are some good and easily farmed soils especially adapted for raising hay. Potatoes are a profitable crop here on the gravelly soils both on account of the quantity that can be raised per acre and the prices that can be obtained. A rotation of hay, potatoes and wheat it seems could be made to pay well. Rye and buckwheat thrive well in the hills of this township. Other sections, especially the steep slope already referred to, should be reforested. West of Roaring Creek the undulating valley of the Hamiltons is a splendid illustration of what has been said above.

Going south from the western section of this undulating Hamilton valley the Chemung hills, of little agricultural value, followed by the Catskill which are hilly and stony in many places, but furnish some good agricultural soils of good Catskill type are met. Little Mountain, of Pocono rock forms the southern boundary of this township with no farming land.

LOWER AUGUSTA TOWNSHIP

Lower Augusta lies south of Upper Augusta. Beside the valley forming Lower Helderberg limestone and the ridge forming Oriskany sandstone along the river near Selinsgrove Junction, this township contains the Hamilton valleys and is not as hilly in these sections. In the valleys and on the divides between Little Shamokin and Plum Creek are some very productive Hamilton soils, and also along the eastern part of the townships.

South of this same Chemung formation, already discussed in Shamokin township, makes a ridge and forms a hilly and in many places unfriendly soil. The Catskill is not as hilly neither not as stony and more easily cultivated. Little Mountain forms the township boundary at the south.

JACKSON, WASHINGTON AND UPPER MAHANOY TOWNSHIPS

Jackson, Washington and Upper Mahanoy form a string of townships extending from the river eastward to Schuylkill county on the same red rock strata, the Catskill and Chemungs.

Line Mountain, of Pocono formation, forms its northern boundary and the Chemung hills south of the Catskill valley, with the exception of a narrow strip of Hamilton on the southern border, the southern. The Catskill valley has a productive soil at such places as along the streams.

Washington township has the same formations and similar soils of good fertility as at such places as Rebuck where some of the best type of Catskill soils occur. Upper Mahanoy, with the exception of a narrow projection of Hamiltons, has the same soils as Washington, with a narrowing of the Catskill formation.

LOWER MAHANOY AND JORDAN TOWNSHIPS

Lower Mahanoy and Jordan townships occupy the southeastern corner of this county, along the Mahantango Creek. The rock strata of these townships range from the Catskills down to the Salina, the latter coming up at Georgetown in Lower Mahanoy township; but this formation does not enter the soil. Swartz's Ridge which forms the northern border of this township, is made by the Selinsgrove sandstone with massive layers forming a rough country. South of this, the Oriskany sandstone enters into the formation of the soil which is largely covered with debris from other sources and is not so much influenced by this sand as it is where the sandstone alone is the mineral substance entering the soil. South of this is a broad level formation at a considerable height above the river, covered with transported materials, forming a loamy soil of good fertility.

The Lower Helderberg limestone is quarried in the vicinity of Hickorytown, where it is not concealed, and burned into lime. The Oriskany sandstone is also exposed here but all formations are very much concealed until Fishers Ridge is reached which, like Swartz's Ridge on the northern boundary, is formed of the Selinsgrove sandstone and is very rugged. South of this ridge the Chemung hills remain which are, however, not as rugged as the sandstone above referred to. South of the Chemung formation is the wide valley of the Mahantango Creek upon the Catskill strata. The valleys throughout this township are fertile and the ridges rough and difficult to farm with little profitable farming soil.

JORDAN TOWNSHIP

Jordan township, like Mahanoy has Swartz's Ridge for its northern and Mahantango Creek for its southern boundary with Fisher's Ridge, similar in formation, about a mile south of it, but uniting with it in the northeastern part of the township giving rise to a rugged section of the county. The Lower Helderberg limestone is exposed along the northern section of the township for about two miles. This stone is quarried here and burned into lime. Sufficient limestone crops out in these two townships to furnish lime for the entire southern section of this county. The soils in the valleys of this township are fertile and the ridges rough.

LITTLE MAHANOY TOWNSHIP

Little Mahanoy township lies north of Jackson and Washington and south of Lower Augusta. The rock strata outcropping in this township range from the coal measures to the Pocono, the latter forming Little Mountain on the north and Line Mountain on the south of the township. Between these two mountains the Mauch Chunk red shale is largely the outcropping rock and forms the basis of the soil which is of good fertility and fairly productive.

Some clay soils occur along Mahanoy Creek, which are not entirely of local origin, but of good fertility. Black oak, rock oak, pine and birch are mostly the prevailing tree forms, all of which indicates a fairly fertile soil. Along the Mahanoy Creek in Cameron township is a valley of Mauch Chunk red shale of similar formation and fertility as that of Little Mahanoy.

ZERBE, COAL AND MOUNT CARMEL TOWNSHIPS

Zerbe, Coal and Mt. Carmel townships are the coal measure townships of this county. The soil formation range from the Mauch Chunk red shale up to the coal strata. The Pottsville conglomerate forms a ridge of extremely rough land along the borders of all these townships except the western borders of Mt. Carmel.

Big Mountain, coming in from Conyngham township, Columbia county, forms this northern border of Mt. Carmel township, while Locust Mountain, coming in from the same township, enters the southern central part of the township. Besides these mountains there are a large number of smaller hills making a country difficult to farm. The rock strata are not, as in the bituminous coal field, interspersed with limestone, but all have changed to sandstone, and consequently the soils are normally thin and infertile in these townships. The valley along Shamokin Creek has some alluvial soils of considerable fertility all of which should be used for trucking in this section where there is so large a demand for all these crops. Few counties of the State have a diversity of soil formation such as this county has. The best uses for these various types of soils have been indicated as the discussion proceeded.

MONTOUR COUNTY

Montour county was erected by an Act of the Assembly, May 3, 1850. It contains 83,200 acres, of which 74,540 acres is land in farms, and of which 60,159 acres is improved farm land. Ten thousand two hundred and one acres were planted with corn in 1909, yielding

246,183 bushels; 9,374 acres were sown with oats, yielding 250,092 bushels; 10,194 acres were sown with wheat, yielding 163,004 bushels; 1,847 acres were sown with buckwheat, yielding 23,682 bushels; 1,627 acres were sown with rye, yielding 16,379 bushels; 864 acres were planted with potatoes, yielding 58,007 bushels; 12,910 acres were sown with all forage crops, yielding 15,355 tons of the various kinds of hay. Of the 60,159 acres of improved farm land, 47,017 acres were used for raising farm crops while 13,142 were not so used and were likely producing weeds. At this time the county had a population of 14,868 to feed, 5,782 cattle, 2,781 horses, 47 mules, 5,373 swine and 653 sheep.

The outcropping geological strata from which the soils of Montour county are formed, begin with the Lower Catskill shale which remain near New Columbia, in Hemlock township, and extend down to the Medina which are brought up by the Montour Ridge. Chillisquaque and Mahoning creeks drain nearly the whole county.

ANTHONY TOWNSHIP

Anthony township occupies the northern part of the county, extending between Columbia county on the east and Northumberland county on the west to Lycoming county on the north. Chemung and Hamilton shales are the only rock strata that outcrop in this township. The harder Lower Chemung strata occupy the northern portion of this township and rise in a steep slope approximately 600 feet above the Hamilton formation and extend northward in a series of ridges and peaks far into Lycoming county. The soils on these hills are usually thin, except as stated in the discussion of Madison township, Columbia county, where the valleys are wide and the uplands cover a broader hilltop, here the soils are productive and with deep plowing, the application of manure and the plowing down of heavy sods and the use of lime, good crops can be produced.

Looking down from the Chemung highlands at the north, the central and southern parts of this township resemble an extensive plain or valley. The soils of this part of the township are formed from the local Hamilton strata wherever these outcrop, as at White Hall, near the eastern border of the township and the vicinity of Exchange, in the central part; whereas, in many of the less elevated sections the soils are partly derived from these local strata together with transported material.

Catskill and Pocono boulders are found all over this valley, sometimes in large heaps. The central and southern part of Anthony township has a productive soil, easily farmed, responds readily to good agricultural treatment, especially to deep and thorough tillage, and the introduction of vegetable matter into the soil. All farm crops

that will grow in these climatic conditions thrive here. Wheat, potatoes and clovers yield profitable crops on the more gravelly sections, while the hay grasses and corn thrive better on the clays and loams.

LIMESTONE TOWNSHIP

This township lies southwest of Anthony and east of Northumberland county. The rock strata of this township range from the Hamiltons down to the Salinas. The northern section of the township is exactly similar in formation to the Hamilton formation of central Anthony. South of this the Oriskany sandstone appears for the first time in a massive form, making a ridge running southeastward from Northumberland county through this township on into Derry to the east with a crest of some height above the surrounding country and with an abrupt northern slope.

South of the Oriskany, the Lower Helderberg limestone, underlying the Oriskany, being more easily disintegrated, makes a long southern slope. The Salina strata, underlying the Helderberg, are also readily acted on by the agencies of disintegration and, therefore, these still further aid the formation of moderate slopes northward. Large quantities of limestone have been quarried from the southern and northern slope of this ridge for agricultural and other purposes.

The soils of this township are among the best in the State, with the exception of the Oriskany sandstone formation, which occupies only a small section of the area.

DERRY TOWNSHIP

Derry township lies east of Limestone and south of Anthony. The rock strata range from the Chemung down to the Helderberg limestone. The Chemung strata occupy a narrow section in the southern part of the township, beginning with a width of about two miles on the eastern border, which narrows to a point and passes out before reaching the western border. This Chemung formation is similar to those already described in other parts of this and other counties, except that the hills are not generally as high and steep. The Hamilton rock underlie more than two-thirds of this township. They have been disintegrated to such an extent that the whole Hamilton section is well nigh a level plain. Some of it with an exceptional soil especially adapted to raising the hay grasses, corn and oats. Wheat also yields fairly well but is not as hard as that produced on the more elevated soils. Some Pocono boulders and other foreign rock enter into the formation of these soils.

The Lower Helderberg limestone, described in Limestone township, enters this township and in the vicinity of Washingtonville are quarries from which this stone has been taken and burned into lime. The

Oriskany sandstone does not make as permanent a ridge here as in Limestone township. This township has equally as fertile and productive soils as Limestone and will produce all agricultural crops equally as well.

WEST HEMLOCK TOWNSHIP

West Hemlock lies east of Valley and Derry townships, on the Columbia county line. Its rock strata extends from the Lower Catskill to the Lower Clinton formation on the Montour Ridge in the southern end of the township. The Catskill strata produce streaks of red soils near the central part of the township, while north and south of this the Chemung hills extend in both directions until they meet the Hamilton formations where they form steep slopes as usual descending into a broad valley. The Lower Helderberg limestone was not seen in this township. The Hamilton, the disintegrated Helderberg and the Salina form a valley of good fertility along the north side of Montour Ridge.

VALLEY TOWNSHIP

Valley township lies west of West Hemlock and south of Derry. Its rock strata, like those of West Hemlock, begin with the Chemung Catskill and extend to the Clinton on Montour Ridge which forms the southern boundary of the township. The Chemung strata form the moderately hilly country of the northwestern and part of the northern part of the township and the Catskill Chemungs the northeastern and part of the eastern part of the township. This section is less hilly than the pure Chemungs and makes a more productive soil.

South of the Chemung ridge the Hamilton, the Lower Helderberg limestone, the Salina and the Bloomsburg red shale underlie the valley between the Chemung ridge and the Clinton shales forming Montour Ridge. This valley has fertile soils adapted to all agricultural crops.

MAHONING AND COOPER TOWNSHIPS

The former lies south of Valley and the latter south of West Hemlock and north of the Susquehanna River. These two townships have exactly similar outcropping rock strata and both have Montour Ridge for their northern and the Susquehanna River for their southern boundaries. They both have the buried valley running westward from Rupert, in Montour township, Columbia county, where the river turns southward, and the Chemung ridge which is cut across by the river southeast of Danville and which shows itself northeastward from the asylum and in a ridge southwestward from Danville where it rises in a high precipitous ridge. Nearly all along the Catskill strata form the river bed.

The Hamilton, the Oriskany, the Salina, though covered up to a large degree throughout this valley likely by the sliding down of the Clinton shales from Montour Ridge, nevertheless make their influences felt in the fertility of the soils throughout the valley. Near the eastern line of Mahoning township the Oriskany sandstone makes a sharp ridge called the Hog Back. This is a limy sandstone and when disintegrated makes a fertile soil. The Helderberg limestone is about all covered up in the valley of this township but its effects are noticeable.

At Danville is a beautiful fertile valley extending eastward and westward along the Montour Ridge forming some of the best market gardening soils occurring anywhere in the State, considerable of which has been used for raising these crops and is now so used.

LIBERTY TOWNSHIP

This township lies west of Derry, Valley and Mahoning and is bounded on the south by Montour and on the north by Lime Ridge. Two broad valleys, one along Lime Ridge in the northern part and the other along Montour Ridge in the southern part, extend across the township from east to west on the Hamilton, Oriskany sand and Helderberg in the northern and on the Hamilton and Helderberg limestone and the Salina in the southern part. The central part of the township, beginning a little west of the center, is more hilly toward the east because of the harder Chemung rock strata remaining in this section. The older Helderberg limestone crops out in the old valley, already referred to, extending along the foot of Montour Ridge, especially at the eastern end where it rises in a high ledge and has been quarried and burned into lime. The upper layers of the Oriskany are sandy and soft. The road from Washingtonville westward is built nearly all the way on the Oriskany sandstone. It makes a good roadbed wherever it is cared for. Limestone Creek rises about 250 feet above Chillisquaque Creek.

This township contains a larger section of fertile soils than either Derry or Valley. These soils contain a sufficient quantity of lime for all purposes except the Chemung formation running through the center of the township. With this exception, the soils of this township will, with the application of manure, produce all agricultural crops that thrive here successfully. The Montour Ridge should be tried out with peaches.

Some of the agricultural practice followed in this county is hay raising, for which a large acreage is especially adapted. One hundred to 120 acre farms are divided into 60 acres of hay, 20 acres of corn, 20 acres of oats, and 20 acres of wheat. Hay is made the chief money crop. No pasturing is done. As many animals, usually cattle, as the

corn and oats will fatten or feed, are kept. The manure is applied directly as it is made and the heavy second growth of the hay field to be planted with corn is plowed down. With this practice followed for years the soils on these farms contain a larger quantity of organic matter than any soils in these northeastern counties. An average of from two to three tons of hay per acre is harvested annually from these soils. These farms are largely underdrained, a good practice for a large acreage of this land.

COLUMBIA COUNTY

Columbia county was taken from Northumberland county by an Act of March 22, 1813. It contains 306,560 acres, of which 228,059 acres is land in farms, and of which 163,936 is improved farm land. Twenty-three thousand five hundred and seventy-four acres were planted in corn in 1909, yielding 548,505 bushels; 21,063 acres were sown with oats, yielding 501,427 bushels; 20,061 acres with wheat, yielding 337,844 bushels; 10,048 acres with buckwheat, yielding 143,-152 bushels; 11,115 acres with rye, yielding 118,315 bushels; 3,992 acres were planted with potatoes, yielding 272,257 bushels; 26,982 acres were sown with all forage crops, yielding 28,822 tons of various kinds of hay. Of the 168,936 acres of improved farm land, 116,835 were used for raising farm crops while 47,101 were not so used and were producing weeds. At this time Columbia county had a population of 48,467 people to feed, 14,199 cattle, 6,757 horses, 338 mules, 16,086 swine and 1,039 sheep.

Columbia county lies east of Northumberland, Montour and Lycoming, south of Lycoming and Sullivan and west of Schuylkill and Luzerne. Twelve outcropping geological rock strata, beginning with the Clinton shales and extending into the coal measures, enter into the formation of the soils of this county, representing the Carboniferous, the Devonian and the Silurian Ages. The townships north of the river are drained by Fishing Creek and its tributaries while those south of the river are drained by Shamokin, Roaring and Catawissa creeks. The townships north of the Susquehanna were covered, when settlers came in, with an immense pine forest, which was removed by girdling and burning the trees which, if these trees had been permitted to remain until this time, would bring more in the markets than the land together with the buildings now would.

The terminal moraine enters this county from Huntingdon Mountain west to Roaring Creek whence it changes northward along Fishing Creek, through Fishing, Benton and Sugarloaf townships on into

Sullivan county. Sugarloaf, northern Benton, Jackson and northern Pine townships are entirely, except northern Sugarloaf and Jackson, within the domain of the Catskill formation.

The North Mountain, a continuation of the Allegheny, capped with Pocono sandstone, makes an extremely hilly and rough country in the northern parts of these townships, fitted only for the growing of forests. The southern slopes of these hills are especially adapted for growing forest trees. Here the glacial drift, the Pocono sandstone and some Upper Catskill strata entered into the formation of the soils and a combination is formed which, if the luxuriant tree growth which occurs here and elsewhere in the more fertile of these formations, can be accepted as evidence, then these are among the best forest soils. Further south, east and west, branches of Fishing Creek, both coming down from the North Mountain, unite. In the vicinity of their confluence, hilly and rolling soil, of glacial materials, largely derived from local strata, exists.

This section from all that could be ascertained, should be devoted, the higher elevations, to raising apples and the lower to raising hay and some of the general farm crops such as potatoes, buckwheat, rye, oats, and corn. Clovers, such as the Canada field pea, alsike and the hairy or winter vetch, and in the glacial soils which here are deep, there seems no reason why with the application of lime, alfalfa should not be raised. These soils do not dry out as do the soils lying close upon the rock strata and they can, the more gravelly of them, be farmed when other soils would be too wet.

JACKSON TOWNSHIP

Jackson township lies west of Sugarloaf, on the Lycoming county line and Little Fishing Creek. North Mountain crosses the north end of it and makes hilly country Pocono rock too rough and hilly for any agricultural operation to be successfully carried on. As far south as Rockville the Catskill strata form the outcropping rock. From here south to the township line the Catskill Chemung and Chemung strata constitute the outcropping rock. The Catskill red shale strata cover approximately the central part of the township and produce soils though rough and in many places covered, especially in the vicinity of Rockville, with boulders, stones and drift, will produce better the cereal crops than where the land is clean but formed of the gray shales and drift material. The elevation above tide in this township ranges from, in the southern part, along Little Fishing Creek, 1,280 in the north.

PINE TOWNSHIP

Pine township lies west of Jackson and Greenwood and has Little Fishing Creek for its entire eastern boundary. The Lower Catskill rock strata cover the township as far south as Lates Run and forms

more moderately rolling land and more productive than the soils further south in the harder Chemung strata. Along Fishing Creek the valley is steep and narrow but the uplands, as is usually the case with the Catskill strata, is moderately rolling. These soils are adapted for apples, potatoes, oats, the hay grasses, such as timothy.

The elevations above tide vary from 590 to 850 feet. The Chemung strata in the southern part of the township are cut into a series of steep valleys with sometimes narrow, and again broader rolling uplands between the streams, of fair fertility, with adaptations which vary as seasons vary, and also, with soil treatment. These soils will produce a fair crop of buckwheat in a moderately dry season but will not produce paying crops of potatoes and corn during such a season.

Madison, Greenwood and Fishing Creek townships have soils of similar origin so far as the underlying rock strata are concerned, but are not similar, so far as glacial debris enters into their composition, is concerned.

MADISON TOWNSHIP

Madison township lies east of Montour and south of Lycoming counties. The northern part of this township, down to the Hamilton shale valley, beginning with the ridge several hundred feet high running east and west through this as well as the eastern part of Greenwood, is covered with the strata of the Chemung shales which form, as usual, a hilly country, with rolling uplands and steep slopes with sometimes narrow and again comparatively broad and fertile valleys. The broad valleys are usually fertile and have clay and loamy soils rarely gravel. The uplands are mostly gravels and loams and when well supplied with organic matter, which these soils consume at an enormous rate, yield well paying crops. These soils are easily prepared for crops and respond to manure, lime and commercial fertilizer, but especially to manure, of which all that can possibly be obtained should be applied.

These same Chemung shales occur along the southern part of this valley forming a ridge similar to that to the north of the valley. Upon this ridge the same type of soil configuration occurs. Between these two ridges the softer Genesee and Hamilton shales have been raised to the surface by a curving up of the rock and a moderately rolling valley of these shales makes the basis of the soils. These Genesee and Hamilton shales produce a more fertile soil because they are softer and yield more readily to disintegrating agencies. In many places through the valley the Tully limestone comes into the forma-

tion and produces a soil rich in lime. Usually the only thing necessary when lime becomes deficient in the surface soil is to plow a little deeper and mix some of the subsoil, by thorough deep tillage cultivation, with the surface soil. Certainly the soils of this whole valley are not of equal fertility as is the case in the vicinity of Jerseytown where heaps of rounded boulders occur even on the highest elevations.

South of the Chemung ridge, already referred to, come the Chemung Catskill; and still further south a section of Catskill red shale soils, near New Columbia, occupying the southern section of Madison and the northern part of Hemlock townships. This soil will produce farm crops well.

GREENWOOD TOWNSHIP

This township, east of Madison, is very similar in soil formation, to Madison having the Chemung ridges along the Genesee and Hamilton formation on both the north and south side with a larger area of the Chemung to the north than Madison and a smaller one to the south.

This township differs from Madison in that a larger soil area is covered with glacial drift and boulders, than in Madison township and therefore the underlying rock strata have not entered into the formation of the soil to the same extent as in Madison, all of which is evident in that the soils are better on the Chemung strata and poorer on the Genesee and Hamilton. On the Genesee, Hamilton and limy shale and glacial drift soils, clovers thrive and alfalfa is being raised at such places as Millville and Jerseytown.

FISHING CREEK TOWNSHIP

Fishing Creek township lies east of Greenwood and Orange on the Luzerne county line. The Catskill strata which underlies this township and which are rarely exposed because covered with glacial drift except along Huntingdon or Fishing Creek Mountain, which forms the southern line of the township and upon which the Pocono conglomerate rises to an elevation of 1,500 feet above tide. Here is no glacial material.

The glacier has piled up a terminal moraine westward along Huntingdon Creek to a height of from 40 to 500 feet which changes its direction northward some distance east of where Huntingdon Creek flows into Fishing Creek. This glacial deposit makes a soil covered with boulders, only a comparatively small part of which can be successfully farmed. The local Catskill strata enter to some extent into the composition of this glacial soil but produce little if any effect. In the vicinity of Rhorsburg the Genesee and Hamilton strata show their effects in producing some oak timber. Northward

from this the Chemung strata underlie the soils and these together with the glacial remains form the soils. The hills are rounded and some of the valley filled which in some instances makes the country less steeply hilly.

Northern Hemlock, northern Mt. Pleasant, Orange, northern Center and Briar Creek townships are underlaid with similar geological strata which form largely the basis of their soils. Beginning somewhat south of the central part of Hemlock township the Chemung strata rises into abrupt hills overlooking the valley to the south and forming a hilly section of land not by any means as fertile as the valley south of it. North of the Chemungs the Catskill shales form the soil which though hilly is better than the hilly Chemungs.

Mount Pleasant contains a continuation of the Chemung section between the Catskill, Genesee and Hamilton, described in the discussion of Madison township. This is a hilly ridge of similar character as those in Madison and other northern townships. The same Chemung formation form a section of within a mile in width a short distance from the southern border of this township. Between these two Chemung series of hills the Catskill remain and enter into the formation of the soils with more rounded and somewhat more easily farmed and more productive hills as is evident from the tree and crop growth. The extreme southern part of the township will be discussed in connection with Bloomsburg and Scott townships.

ORANGE TOWNSHIP

Orange township lies east of Mount Pleasant and south of Greenwood. It is one of the hilly and rocky townships of the county. Knob Mountain, near Orangeville, is the end of the Pocono or Lee and Huntingdon Mountain further north and referred to in the discussion of Luzerne county. This mountain makes a bold knob between 1,400 to 1,500 feet above tide, from the summit of which a magnificent view can be had of all of Columbia and Montour counties to the northwest and a large part of Luzerne county to the east.

There is no farming land on this knob. Below the Pocono formation the Catskill strata form a broad belt across the township from east to west. Large boulders, often in heaps, are scattered over the Catskill section of this township and therefore what soils are here are rough and stony. To the north and south of the Catskill the Chemung strata appear in similar hilly formations as previously discussed.

NORTH CENTER AND BRIAR CREEK TOWNSHIPS

North Center and Briar Creek townships both lie east of Orange. These townships have Huntingdon Mountain for their northern boundary. The same Pocono formation already described occurs here. The

Pocono and Upper Catskill strata make the steep slope of the east side of this mountain. These Lower or Catskill strata spread out in a plain, widening and again narrowing between these Pocono Catskill hills and the Chemung hills to the south of the valley.

The soils of these hills of Pocono and Catskill are well adapted to tree growing as is evident from the young wood that is growing wherever sufficient soil has accumulated for trees to take root. Apple trees look thrifty and bear well.

The valley between the formations, above referred to, the Upper Catskill and Chemung, is covered with debris so that the rock strata which have entered into the formation of the soil are not exposed except along the side of the hills to the north. South of this valley and north of Berwick the same Chemung ridge, already referred to, rises from 200 to 300 feet above the Hamilton shale valley in which Berwick is situated and a considerable height above the valley of the Catskill formation. These Chemung ridges have thin soils that easily wash and, therefore, except the lower and wider valleys or on the larger and rolling upland sections should not be farmed but should be allowed to grow timber.

Southern Hemlock, northern Montour, Bloomsburg, Scott, southern Center and Briar Creek are located in the loamy formation of this county.

SOUTH BRIAR CREEK TOWNSHIP

The town of Berwick is situated on the eastern line of this township. About a mile west of this town is the eastern extremity of the outcrop of the Helderberg limestone. From this place westward to Briar Creek the limestone outcrops at a number of places and is burned into lime, of good agricultural quality, anaylses of which will be given under the discussion of Center township. From these outcrops southward and from the town of Berwick westward and northward in the plain upon which this town is built, are soils made of boulders and river and glacial materials of good fertility and adapted to raising agricultural and garden crops of all varieties that will thrive in this climate.

SOUTH CENTER TOWNSHIP

South Center township contains rock strata ranging from the Lower Helderberg limestone down to the Bloomsburg red shale. Limestone Ridge is the most extensive outcrop of limestone in this township, or even in this county. This ridge begins very abruptly rising above the level plain, spreading southward, to a height of 110 feet and from 60 to 70 feet above the plain spreading northward.

The following analysis will give the composition of the various grades of stone occurring in this ridge.

Specimens H5Q Section.	Carbonate of lime.	Carbonate of magnesia.	Oxide of iron and alumina.	Phosphorus.	Siliceous matter.
Specimens H 5 Q Section,	88.45	4.78	0.66	0.02	6.26
Specimens H 8 Q Section,	82.37	7.79	1.19	0.23	8.83
Specimens Basdord. L. Stone,	70.98	5.63	3.44	0.032	19.51
Upper Part Bassordville. L. Section,	92.31	3.90	0.53	0.006	3.34
Middle Part Bassordville. L. Section,	96.12	1.76	0.50	0.0006	1.82
Lower Part Bassordville. L. Section,	94.26	1.93	0.55	0.02	3.48
Lower Part Bassordville. L. Section,	93.37	2.00	0.63	1.04	4.17

Pa. Second Geological Survey, G7 R 90.

Here is where the lime for the northeastern part of the State should be gotten because the haul is comparatively short, anthracite coal is within easy reach and the stone can be easily quarried and burned. In the vicinity of this lime ridge is some of the most fertile soil in this or any county of the State, adapted to the raising of all agricultural crops.

Westward from this, the Bloomsburg red shales come into the formation in the eastern extremity of Montour Mountain and forms red soils of good fertility which seem to need no lime, but only deep plowing and thorough cultivation to make them productive. Some of these soils are frequently so deeply covered with debris that this practice will not be successful, and where this is the case lime should be applied. Throughout these formations the soils are fertile and well adapted for raising agricultural crops especially wheat, a lime loving plant.

SCOTT TOWNSHIP

Scott township lies west of Center. The Clinton shales, the Lower Helderberg limestone and the Salina formation, being easily acted on by the agencies of disintegration, make a valley of considerable extent westward across the northern part of the township. This valley contains many boulders which extend to the south across the divide between Fishing Creek and the river. Along the southern part of the township the Helderberg limestone is quarried and burned into lime, a short distance from the eastern township line northeast of Espy and other places. Here is a fertile valley with soils adapted to all agricultural crops.

BLOOMSBURG TOWNSHIP

This township lies west of Scott. Bloomsburg, the county seat of the county, is located in this township. The Susquehanna River and Fishing Creek, which empties into it west of Bloomsburg, have formed a valley of fertile soils several miles in length and more than a mile wide in the vicinity where these streams meet. Along Fishing Creek in the northern part of the township, are similar soil formations, especially from the curve of this creek southward. Similar formations of soil extend westward on the north and south sides of this ridge which causes the curve in the creek, well adapted to all agricultural crops. Here are soils also adapted for market gardening, for the products of which markets are open within easy shipping distance. Montour Ridge passes through the center of this township. On this ridge are located the old iron ore mines which furnished ores for the Bloomsburg and Danville furnaces. The hills, it seems, should be especially adapted for apples and peaches. This same formation, the iron sandstone of which this ridge consists, on it peaches were grown years ago in Snyder county.

Going westward through central Hemlock and central Montour townships, the former to the north of Montour Ridge and the latter to to the south of it, both having similar underlying rock strata through the Genesee, Hamilton, some Oriskany sand, the Salina and the Bloomsburg red shale down to the Clinton which forms Montour Ridge upon which a little Medina sandstone occurs similar soil formations occur as those described in the discussion of Bloomsburg. Scott and Center townships and, therefore, need not be described here.

MIFFLIN, MAIN AND CATAWISSA TOWNSHIPS

Mifflin township lies immediately across the Susquehanna River, south of Briar Creek and Center, and west of Luzerne county. It extends southward from the river to Nescopeck Mountain. The rock strata outcropping, which enter into the formation of the soils of the township begin with the Pocono beds on the Nescopec Mountain and run down to the Helderberg limestone on the river.

The hard Pocono beds rise steeply from the undulating plain of the Catskills which extends from the Chemung ridge southward to this mountain. The Chemung rocks form the ridge between the Hamilton and Marcellus formation along the river and the Catskill plain already referred to. The soils of the Catskill formation are nearly all red or of a reddish hue and evidently they contain a limy or alkali element because with good cultivation and deep plowing, wherever

possible, clovers will grow without lime. A narrow section of soils of good fertility occur along the river at Breezy Station and Mifflinville.

MAIN TOWNSHIP

Main township lies directly west of Mifflin, and all its agricultural soil formations are similar to those of Mifflin, with the exception of a few small sections on the Catawissa Mountains.

CATAWISSA TOWNSHIP

Catawissa township lies directly west of Main. The Catawissa Creek flows through the central portion of this township into the Susquehanna River, at its western extremity. The rock strata of this township extend from the Pocono sandstone, on the summit of Catawissa Mountain, to the Hamilton in the bed of the Susquehanna River. The hard Chemung strata extend up to, or closely to the river, and, therefore, wherever these reach the river there is little agricultural land; but where this is not the case sometimes a narrow strip occurs. South of the Chemung ridge, along the river, the Catskill red shales form the soils to the southern extremity of the township. These red soils produce well all farm crops. It seems that a winter wheat of peculiar hardness and better flour making capacity can be produced on these undulating Catskill soils than on the more fertile limestone soils of the valley. This is something that should be thoroughly tested.

Kentucky blue grass grows naturally on these red soils. White oak timber also thrives here, which, as soon as the Chemung soils on the north and the Pocono on the south are reached, disappears. Apples, especially the Baldwin, of splendid flavor and high color can be grown along this entire Catskill rolling plain extending through Catawissa, Main and Mifflin townships. The spurs of Catawissa Mountain extend along the eastern border of this township on which some farming is done but the soils are generally rough and difficult to farm.

FRANKLIN AND ROARING CREEK TOWNSHIPS

Franklin and Roaring Creek have soils of similar origin as those of Catawissa. The northern part of this township is covered with drift materials of Pocono, Catskill and Pottsville conglomerate boulders of various sizes. This material is found on the highest part of the dividing ridge between the Susquehanna River and Roaring Creek which crosses the township just south of the center. The Chemung strata here do not form as decisive an elevation as they do north of the river in Greenwood and other townships. The red Catskill soils occur in this township, but are not as well exposed as in Catawissa but where they do occur are equally fertile.

LOCUST TOWNSHIP

Locust township lies south of Franklin and north of Little Mountain, which partly forms its southern boundary. North of Little Mountain, the Catskill strata have disintegrated and form a valley of considerable width and good fertility extending the entire length of the township and widening until these strata cover the whole of the eastern section. North of this Catskill valley, in the western and central parts of the township, the Chemung strata form a high ridge similar to those in other parts of this county with a soil not any more fertile than elsewhere.

ROARING CREEK TOWNSHIP

This township lies east of Locust and has Catawissa Mountain for its eastern boundary. The Upper Catskills form the only agricultural soils of this township, nearly all of which are rough and stony. East of Kearnsville, on the divide of the streams, is some moderately rolling land with the soil of the Catskill red shale of good fertility and well adapted for apples. This whole township, especially the Catskill soils, are well adapted for apple growing and should be used for this purpose.

CONYNGHAM TOWNSHIP

Conyngham township occupies the southern extremity of this county. This is a very rough, stony and rocky township. The Pottsville conglomerate forms Big Mountain in the northern and Locust Mountain in the south central part. At Ashland some farming is being done and northward along the line between this township and Northumberland county.

SCHUYLKILL COUNTY

The territory now embraced within the limits of Schuylkill county is a portion of that which was purchased from the Six Nations for $500 by the treaty of August 22, 1749. It contains 497,280 acres, of which 216,348 acres is land in farms, and of which 142,370 acres is improved farm land. Fourteen thousand eight hundred and fifty-five acres were planted with corn in 1909, yielding 242,414 bushels; 14,911 acres were sown with oats, yielding 312,403 bushels; 11,253 acres were sown with wheat, yielding 194,543 bushels; 1,563 acres were sown with buckwheat, yielding 18,243 bushels; 12,862 acres were sown with rye, yielding 166,793 bushels; 7,694 acres were planted with potatoes, yielding 496,463 bushels; 35,711 acres were sown with all forage crops,

yielding 41,471 tons of the various kinds of hay. Of the 142,370 acres of improved farm land, 99,849 acres were used for raising farm crops while 43,521 were not so used and were likely producing weeds. At this time Schuylkill county had a population of 207,894 to feed, 14,746 cattle, 5,912 horses, 1,046 mules, 9,521 swine, and 382 sheep.

This county lies north of Dauphin, Lebanon, Berks and Lehigh and partly east of Lebanon, Dauphin and Columbia, south of Northumberland, Columbia and Luzerne and west of Carbon. The county is hilly, as a whole, and the Kittatinny Mountains from east to west range at nearly uniform elevations at their summits from 1,600 to 1,800 feet above tide.

The North or Blue Mountain summit forms the dividing line between Lehigh, Berks and Dauphin counties on the southern border and the Line Mountain on the north forms the line between Northumberland and Columbia. In line with the North Mahanoy Mountain some distance the line trends north, northeast and east embracing three townships, North Union, Union and East Union. The principal ranges consist of the Mahanoy, Mahantango, Broad, including Locust, Little, Bear, etc., from north to south, until Sharp Mountain, the dividing line between the Carboniferous and Devonian systems, are reached, followed by the Second Mountain to the first North or Blue Mountain. These formations are designated to indicate the great variety of soils throughout the county embracing three principal divisions in its geology, viz: Upper Silurian, Devonian and Carboniferous. The county is well supplied with water of great purity where not contaminated with coal washings. Wells, springs, small streams, and those of considerable size afford ample drainage into the Schuylkill, Swatara and Susquehanna rivers. The streams of sufficient volume for power and general utility are being preempted and chartered for speculative purposes and for immediate use in towns and villages.

Once a dense growth of forest plants and forests prevailed such as are indigenous to the soil and climate. The nature and fertility of the soil is readily distinguished from the native growth, the most fertile producing the valuable hard woods, while the less productive yield the lighter woods requiring less potash, so that pines, hemlock and chestnut thrive on Chemung soils, while the Silurian and Catskill valleys and ridges produce mixed forests, including some of the hard woods indicative of a soil richer in the elements of plant food.

SOILS

In a general way east and south of the Allegheny range, the country is a succession of hills and valleys with the bed rocks crushed, twisted and folded into innumerable arches, elevations and depressions so

that the surface soil varies according to the strata from which it is derived. Running parallel with the higher ranges are numerous ridges ranging from eight to twelve hundred feet elevation, with narrow valleys and rolling hills between which occur the agricultural soils of Schuylkill county. From east to west there is a general uniformity of soil, beginning with the Clinton formations next to the Blue Mountain. The valley is somewhat undulating and narrow at its western end and widens eastward. The red shale of this formation is warm and generally productive, especially where the softer strata appear at the surface which disintegrates readily and makes a productive soil, with comparatively large water holding capacity and rather large fertility holding capacity, while some of the same formation has strata of a more compact and harder texture, producing a rough, stony and less desirable soil condition.

The following townships have soils derived from the Clinton strata: Pinegrove, Washington, South Manheim, North Manheim, West Brunswick, East Brunswick and West Penn. As previously stated, these soils are warm and can be cultivated early in the spring, and early or late sown fall crops can make an early start the following spring, and spring sowing can be done in these soils especially the loams and sandy loams earlier than in the fine loams, and these crops can make such a beginning as to give them a vitality that will put them into a condition to resist drought that sometimes curtail crop yield in some of the soils with a lower fertility and water holding capacity in which crops can not make as early a start or which can not be cultivated nor sown with crops as early as these soils can. It seems with such conditions and with the markets in the nearby mining districts, that these soils should be largely devoted to raising early and late truck crops (early and late in this section) so as to take advantage of the soil moisture early in the spring and later in the summer and fall.

The legumes find a congenial environment in the soils derived from the more limy strata of this formation, especially alfalfa, red and mammoth clovers on the rolling and higher elevations while alsike clover might do better on the lower land. Wheat produces fairly large yields of splendid milling quality and good weight. It seems that this would be one of the sections in which the raising of seed wheat and clover seed could be made a paying industry. Potatoes make fairly large yields in these soils. It seems that a rotation of clover, the first crop cut for hay, the second for seed and the sod plowed down, and the land planted with potatoes and these followed with wheat and the wheat with clover, or the potatoes followed with rye and winter vetch, these plowed down the following spring or mowed for roughage and the land sowed with oats and Canada field

peas, and these followed with clover and the clover with potatoes, would produce results. This latter would, it seems, maintain and increase the productive capacity of the soil and would make the feeding of more animals possible and make as large financial returns as the former. Corn also produces large crops in these soils, and a rotation of corn and with the corn, cow horn turnips, crimson clover, rye, and winter vetch and these plowed down the following spring and the land sown with oats and these followed with wheat and the wheat with clover or alfalfa, would produce more human food and maintain more permanently, the fertility of the soils than any of the previously suggested rotations.

PINEGROVE TOWNSHIP

This township occupies the southwestern corner of the county, with the Lebanon county line for its western boundary and the Berks county line for its southern. As previously indicated, the red shale valley is narrow. The same is true of Washington and Wayne townships, the former lying east of Pinegrove and the latter east of the former, both on the Berks county line.

SOUTH MANHEIM TOWNSHIP

This township lies east of Wayne also on the Berks county line. In this township the Clinton formation widens, as previously indicated, as it approaches the Schuylkill River along which it is approximately three times as wide as in the township previously discussed with a larger acreage of fertile land adapted for raising the crops previously referred to.

WEST BRUNSWICK TOWNSHIP

West Brunswick township lies east of South Manheim and contains a larger area of soils, covering the whole eastern part, derived from the Clinton shales, than any other township in the county. Red Valley east of Orwigsburg is one of the fertile sections of this township or of the county, with soils splendidly adapted for raising the cereal grains, wheat and corn. Otherwise the soils are similar with similar capacities and adaptations as those previously described.

EAST BRUNSWICK TOWNSHIP

This township lies northeast of West Brunswick with the Berks county line for its southern boundary. The soils of the southwestern and southern part of this township are derived from the Clinton strata. The land is rolling to hilly throughout the whole of this formation, easily farmed, needing in the loamy and sandy loams, in many places only deeper plowing and thorough cultivation to produce the same results as liming.

Paralleling the Clinton formation and extending through the same townships is a strip of Lower Helderberg limestone of no commercial value until the eastern part of the county, near the Carbon county line is reached where it is used to some extent for burning lime. But throughout the whole extent of its outcrop it enters into the formation of the soil and makes it better, while where the outcrops are of some extent, it seems it could be crushed and finely ground and applied on the soils derived from the Chemung shales with good effect.

WEST PENN TOWNSHIP

This township lies east of East Brunswick, with the Lehigh county line for its southern and the Carbon county line for its eastern boundary. The Clinton formation narrows down in this township to its original dimensions in Washington township with soils similar in capacity and adaptation.

Next to the limestone and running parallel with it, comes in the Oriskany sandstone, the dividing line between the Upper Silurian and the Devonian systems. The soils derived from the Oriskany and grit varies in some localities where the fossiliferous strata and softer sandstone comes to the surface it is farmed successfully, while much of the rougher portion is in forest principally chestnut and other soft woods, on hills upwards of 1,000 feet elevation. Along the borders of the sand ridges a shale occurs and where this disintegrated shale alone makes the soil it is a close tenacious clay, often underlaid with a persistent hard pan, while the soils derived from the mixture of the two through the sandy deposits by gravity and rains produces a very productive soil, with large water and fertility holding and crop accommodating capacity. The Oriskany formation is a hill maker, the harder portions of the formation of blocks of sandstone being more resistant to disintegration than the clay shales, it maintains a higher level and often a rough stony surface. The more stony, gravelly and steeply hilly sections are splendidly adapted for apple raising, of which these soils will produce vigorous disease resisting trees which yield large crops of well developed, nicely colored and flavored fruit. This formation extends throughout the townships previously named.

Next to the Oriskany, the Hamilton formation in parallel lines occur a deposit of slaty shale, varying in color; the upper division consisting of a close-grained slaty carbonaceous black shale of little agricultural value, making, however, good road materials, except where the limy strata occur and where disintegration of the softer shales has proceeded far enough to make rolling sections with fairly deep warm early spring farming soils, having somewhat the appearance of coal. The ridges in which it occurs throughout the

length of the county have been drifted, shafted and tunneled at the sacrifice of labor and money always with the same result, loss and disappointment. Being thousands of feet below the coal measures, it is a waste of time to attempt finding coal in these stony ridges. This formation also extends through the townships pre viously enumerated.

The next higher in the deposits occur the Chemung shales, of yellow hue forming the most extensive valleys and rounded hills, constituting the most extensive agricultural soil between the First and Second mountains. It is naturally a poor soil, easily worked, leachy, as a rule, but is made to produce successful crops with the use of manure and fertilizers. There is, however, little uniformity in this formation owing to the folded condition of the bed rock which brings to the surface various layers so that the nature of the soil depends upon the native rock strata forming the soil. When neglected or abandoned, the soil derived from the Chemung shale will produce wood, fern, dewberries, cinque foil and poverty grass, golden rod and asters. It also reforests itself with white and pitch pine, as observed in Fulton county and other localities distant from markets, where fertilizing is not practiced.

The Chemung soil has somewhat the appearance of the Utica and Hudson River formation south of the Blue Mountain, especially adapted for raising potatoes and peaches, also general farm corps under favorable conditions. As previously stated, the loamy soils derived from the Chemung shales are among the easy farming soils, can be farmed early and worked when they are wet without any injurious effects, a property that should be taken advantage of and the soils prepared and seeded as early as possible with such crops as will make their main growth during the spring and early summer months when these soils with their limited water and fertility holding capacity will usually contain, if manure has been applied a sufficient quantity of water to start and partly finish such crops before the dry weather sets in. These soils will consume large quantities of organic matter, or in other words, organic matter readily decomposes in these soils and the fertility it contains is made available, and with the leachy condition of the soil, unless the roots of a growing plant are ready to take up this fertiltiy and rebuild it into a new plant soon passes beyond the reach of plant roots and may not be recovered, therefore growing plants should at all times, in so far as possible be maintained on these soils. These soils are also well adapted for raising fall sown, early summer ripening crops, such as rye, and probably winter oats, among the cereal grains, and winter vetch and crimson clover among the fall sown annual cold weather legumes.

It seems that raising the vetch and crimson clover seed, especially the vetch seed, could be made a profitable money crop, while at the same time the productive capacity of these soils could be maintained and even improved. This formation extends through all the townships, above discussed, but is more extensive in West Penn than in any of the townships referred to with probably more fertile land than in any of the other townships. In the central part of Wayne, the northern central part of South Manheim and the eastern central part of West Brunswick a strip of soils derived from the Catskill red shale which caps the Chemung and is known as "Summer Hill," forming a good soil for raising the general farm crops, such as will thrive under prevailing climatic conditions, but especially adapted for raising apples of which it will produce vigorous disease resisting trees, that will produce large yields of highly colored, nicely flavored, well developed apples. It is likely that the Northern Spy and the Baldwin would find a specially congenial soil and climatic environment here. With such natural adaptations and with the demand for apples throughout this vicinity as much of this land should be planted with apples as is accessible, and such soil improving crops should be grown as experience will demonstrate are best suited to keep the soil in the best condition to produce and ripen such a wood growth as will make it possible for the trees to produce annually such crops of fruit as will be up to their capacity but will not overtax it.

Passing from the various hills and valleys northward, across the Hamilton and the Chemung the Second Mountain appears, along the foot of which a strip of red sandstone, the Catskill outcrops, forming the southern half of the range. In appearance the soil is similar to that of the Clinton formation, near the Blue Mountain, being on the whole more rocky and rough yet fairly productive. A transition group between the Chemung and Catskill with alternating red and olive shale, appears, making a deeper, warmer and more fertile soil with a larger water holding capacity than the soils derived from either of these formations separately.

This strip of Catskill soil extends along the northern boundaries of Pinegrove, Washington, Wayne, North Manheim, West Brunswick and East Brunswick into eastern West Penn. In the southern part of Walker township, which lies north of East Brunswick and west of West Penn, the mountain curves northward and the Catskill formation curves with it and the soils of all of eastern Walker township, except the northern corner, are derived from this formation. In the central part of Walker township the mountain and the Catskill formation again curve northeastward and passes into West Penn township and extends along it until it passes into Carbon county. The soils of the southern slope of this mountain, ex-

tending through these townships, are similar in capacity and adaptation to those derived from the same formation previously discussed and in so far as possible should be devoted to raising the same crops, especially apples. Potatoes and the regular farm crops, especially rye and some of the legumes, thrive here and such a rotation of crops should be adopted by means of which monetary returns could be realized and the land improved.

Another section of Catskill soils occurs in Upper Mahantango and Eldred townships in the northwestern corner of the county north of the Mahantango Mountain with similar capacities and adaptations as those previously discussed. The crest of the Second Mountain, which makes the boundary line between these southern townships and the townships of the coal fields, is formed of the Pocono sandstone, with rough, stony and mountainous land of no agricultural value. North of this mountain the Mauch Chunk red shale makes a long narrow valley extending through Tremont, Reilly, Branch, Blythe, Walker and Rahn townships or through the entire length of the county in a northeasterly course. The soils of these townships are stony and rough except at such places as the section of it in Walker township and thence eastward, and in sections east and of Schuylkill river south of Pottsville where some more moderately rolling land occurs. Another triangular section of the Mauch Chunk red shale soils occurs in Potter township lying north of Tremont township on the Dauphin county line and discussed in connection with the county.

A third section of soils derived from these same shales also coming in from Dauphin county and comprising nearly the whole of Hubley, Higgins, Barry and Butler townships, nearly the whole of it lying south and east of Mahantango Mountain divided largely into two valleys the one on the north following Deep Creek which rises in the eastern part of Barry township and flows westward, the other following Pine Creek which rises in eastern Higgins township and also flows westward until it changes to a northern course west of Sacramento where it empties into Deep Creek and from whence the two valleys unite.

A fourth section of soils derived from the Mauch Chunk formation occurs in the northern and northeastern part of the county embracing the larger areas of Union, North Union, East Union, Kline, Rush and Ryan townships. These soils are stony gravelly and some sandy loams on the slopes and the higher elevations, the gravels occurring mostly where the underlying strata come close to the surface while the stony loams occur where disintegration has penetrated deeper. The fertility and capillary active water holding capacity of these soils is limited because of the material from which they are derived and, therefore, plants will usually suffer for suffi-

cient water during part of the growing season unless covered with a vegetable mulch such as manure or a sod or a dust mulch which, in these soils, does not do as much good as in soils with a less limited capillary activity. Manure and all other vegetable fertilizng and mulching materials should be maintained in so far as at all compatible with the crops on or close to the surface, and when mixed with the soil, mixed only with the surface so that some capillarity might be maintained there. The soils of the valleys throughout the Mauch Chunk formation are derived from the underlying upturned shales and the clayey and shaly materials brought down from the surrounding hills.

The soils of some of the valleys are underlaid with a conglomerate material upon which the clay and shale of the surrounding hills is deposited. These formations extend to the slopes of the hills, and as the water cannot penetrate to any great depth in either formation, the land is usually too wet in the springtime and sometimes late into the spring to start cultivation or raise cultivated crops, and with such conditions little is produced; and unless these valleys are underdrained, especally the valleys, underlaid with upturned rock with the thinner soils and the valleys with the deeper soils are plowed deep and thoroughly cultivated and a large quantity of organic matter incorporated with the soil, these soils will not produce, but when either of these operations are thoroughly performed and after several winters of thorough freezing and thawing, they become tillable and have large water and fertility holding capacity and will produce the regular farm crops, such as rye, oats and corn, and among the fall sown, long season legumes, the alsike and red clovers, and among the annuals, the winter vetch and likely the crimson clover, and among the spring sown the Canada field pea. An arrangement of crops could be made with such an array of crops that will thrive in these soils so that a soil improving crop may be raised with or be made to follow a soil exhausting crop and the fertility of these soils maintained and even increased.

The soils of the remaining townships of this county, beginning in the western part with Frailey and Foster and going eastward to Branch, Cass, Norwegian, New Castle, East Norwegian, Blythe, Schuylkill and Rahn, through the central part of the county and in the northern part, northern Butler, West Mahanoy and Mahanoy, the land is hilly, mountainous and rough, with soils derived from the Pocono sandstone and the Pottsville conglomerate, of no agricultural value, while in the coal basins are small areas with soils derived from the coal shales and sandstone of considerable agricultural value much of which is being farmed

and within the present generation will be more extensively cultivated, by the foreign people who are working the mines, both for raising truck crops as well as for raising crops for feeding dairy cows.

CARBON COUNTY

Carbon county was formed by an Act of the Assembly, March 13, 1843, from parts of Monroe and Northampton counties. It contains 259,840 acres, of which 96,303 is land in farms, and of which 40,087 acres is improved farm land. Three thousand eight hundred and ninety-three acres were planted in corn in 1909, yielding 89,366 bushels; 4,574 acres were sown with oats, yielding 105,337 bushels; 1,366 acres with wheat, yielding 22,838 bushels; 1,650 acres with buckwheat, yielding 25,796 bushels; 5,340 acres with rye, yielding 65,714 bushels; 1,854 acres were planted with potatoes, yielding 140,566 bushels; 8,956 acres were sown with all forage crops, yielding 10,333 tons of various kinds of hay. Of the 40,087 acres of improved farm land, 27,603 acres is used for raising crops, while 12,484 were not so used and were likely producing weeds. At this time Carbon county (1909) had a population of 52,846 people to feed, 4,587 cattle, 1,871 horses, 67 mules, 2,148 swine and 96 sheep.

THE SOIL FORMATION OF CARBON COUNTY

Carbon county begins in geological structure with the Medina sandstone and the Oneida conglomerate and ends with the coal measures, and it contains over 19,000 feet of the three Silurian, Devonian, and Carboniferous rock within its territory.

EAST PENN TOWNSHIP

East Penn township occupies the southwestern corner of the county and extends from the Schuylkill county line to the Lehigh River and the Lehigh county line on the south. Beginning with the top of the Blue Mountains and coming down, the soils of these slopes are formed, or have for their bases, the Oneida conglomerate, the Medina sandstone, and the Clinton shales on the lower side. Nearly this entire mountain side is not fitted for agricultural crops and should, therefore, be allowed to remain in forest, or where the forest has been destroyed should be reforested. Some of this land has been planted with apples with considerable success especially the Kemerer orchards, south of Burgess. Along the Clinton shale lays

the Helderberg limestone, which is quarried and has been used for making lime in this section for a number of years as the old lime-kilns, the ruins of which still exist along the valley indicate.

Following the limestone, the Oriskany sand forms a ridge in many places so incompletely disintegrated that the skeleton piles still stand, of an at one time immense rock system. The disintegration of this sand rock has, in connection with the lime and limy Marcellus shales, formed in many places a rough but fertile soil, the rougher or more stony especially adapted for fruit and the sandy and loamy for agricultural crops. Lizard Creek flows on the Marcellus shale until it reaches Ashville when it flows on the limestone. Here the valley, as already indicated, is narrow and hilly and the soil stony. At Ashville (sometimes called Ashfield) or some distance east of it, the valley widens and is widest at Lauchners at Stony Hill. The Marcellus, Hamilton, and Genesee shales, forming the soils which, with cultivation and the addition of organic matter, will yield large returns in agricultural crops, such as wheat, rye, oats, corn clover and the hay making grasses, as well as potatoes. Cultivation and the addition of organic matter are the keys in the farmers bosom that will unlock the door to agricultural property in this section. Further southwest to Andrews, in Schuylkill county, the valley narrows and the sides become so hilly that successful farming is well nigh out of the question, but the soils of these hills though steep are fertile.

What has been said of East Penn township, can be said of Lower Towamensing township or northeast of the Lehigh River. Its soils are formed from the same rock, geologically, except that as it approaches the Monroe county line, the upper Helderberg limestone enters and becomes a factor, and a very desirable one, were it not for the facts that the soils are stony, the rock in many places coming close to the surface and makes farming operations difficult. The Aquanchicola Creek flows in from Monroe county on the Clinton shale and empties into the Lehigh River at Lehigh Gap. This creek forms a valley wide enough in many places to have alluvial soils similar to, but not as extensive as the soils along the Delaware adapted for trucking. Another section that should be referred to is at Millport where the limy Marcellus shales form a fertile soil adapted to all agricultural crops.

MAHONING TOWNSHIP

Mahoning township, west of the Lehigh River, is the largest farming township in the county. Mahoning Creek, forming Mahoning Valley, enters the county from Schuylkill and flows into the Lehigh River opposite Weissport traversing the entire length of the

township. The creek flows on the Genesee shales, while the Chemung shales from the hillsides and the Catskill rocks, the hill tops especially along the northern boundary of the township. The farming is not confined to the Mahoning Valley, but extends along both sides and on top of the Mahoning Hills on the southern boundary of the county. The mingling of the Chemung shales and the Catskill rock in the formation of soils on this mountain has resulted in the production of soils among the most fertile of these two formations anywhere in the State. Blue grass grows naturally here. Wood growth is so dense that sunlight and moisture seem the limiting factors instead of fertility. The original forest was the varieties of oak, including the white oak, chestnut and hickory, with some few pine. Nishollow, a small valley in the Mahoning hills, has a soil formed of the Chemungs and the Genesee and Catskill rocks making fertile land. Beaver Valley on Beaver Run, flowing into the Lehigh River at Packerton, has some fertile soils, but the more preferable are the tablelands on the hills both for farm crops and for fruit. Lehighton, a town of considerable size, is located in this township.

FRANKLIN TOWNSHIP

Franklin township, on the east side of the Lehigh River, is located, geologically, in the same formations as Mahoning township, except that instead of the Genesee shales forming the creek bottom of the Pahopoco Creek, the Hamilton shales form this bottom, beginning a short distance east of Weissport and continuing the entire length of the county. Along this creek, especially the south side, the land is hilly, and some steeply hilly, and not suited for agriculture but for forest, while to the north on the Hamilton, Genesee and Chemung shales and on the Catskill rock is good farming soil. Wheat seems to do well on these soils with good farming as high as fifty bushels per acre have been raised.

TOWAMENSING TOWNSHIP

Towamensing township has a continuation of the same soils, except that the Catskill rock become more prominent a factor in the soils at such points as Simlersville where a valley opens from the southwest and from whence an extensive farming country opens toward the northeast to Carbon P. O. or Trachville and to Kresgeville in Monroe county, having soils derived from a commingling of Catskill, the Chemung, the Genesee and Hamilton shales. Blue grass grows along the roadsides over this entire country. The crops raised are corn, oats, rye, sometimes wheat, buckwheat, some potatoes and the hay making grasses. Apple trees when cared for grow well and produce a beautiful well colored fruit.

MAUCH CHUNK TOWNSHIP

Mauch Chunk township has only a small acreage of farming land, located in Bloomingdale Valley, along Mauch Chunk Creek, on the Mauch Chunk red shale nearly on the southern border and the valley of the Nesquehoning Creek on the northern border of the township, both on the Mauch Chunk red shale and both quite fertile valleys, with markets at their doors in the coal region of the county for all that they can produce. Here, market gardening and dairying, in so far as possible, should be the chief agricultural industries. Broad Mountain, made of Pocono sand, occupies more than half the area of Packer township. This part has a soil that has scattered over farms here and there and some good farming is done but it is so widely scattered that the possibilities of this soil have not been demonstrated. Grasses such as orchard, timothy, rye and oat grasses thrive here, and it seems with this natural tendency developed that stock raising could be made a paying industry.

Quakake Creek, coming in from Schuylkill county and flowing well nigh its entire course along the line between the Mauch Chunk red shale and the Pocono sand with a soil, partaking of both formations making a soil that with good treatment in the way of cultivation and the application of manure and turning down of sods, will here, ith such market facilities, yield returns not equalled in more fertile soils of the State.

BANKS TOWNSHIP

This township occupies the northeastern corner of this county, with the Luzerne county line for its northern and the Schuylkill county line for its western boundary. All of this township, except a small section in the eastern part, lies in the Beaver Meadow coal basin. The soil of the township is formed of the Mauch Chunk red shale, the Pottsville conglomerate and the sandstone of the coal formation. At Beaver Meadow, along Beaver Creek and thence westward, is some farming land that will produce truck crops in paying quantities. The pasture grasses thrive as well here as on the more rolling sections of the township generally. The land is hilly and rough and much of it should be in forest or reforested.

LEHIGH TOWNSHIP

Lehigh township is geologically like Packer, except that near the Oxbow Bend of the Lehigh River, at Rockport, where the middle coalfield and Lyretown Asylum, are located, is quite an acreage of soils, adapted for crops such as potatoes and market gardening and the grains, such as oats and the clover needed to feed the animals for

working the farm and to furnish milk for the inmates. At Weatherly is another farming district on the Mauch Chunk red shale that yield good returns for all efforts bestowed on it.

FOREST, PENN AND KIDDER TOWNSHIPS

The soils of Penn, Forest and Kidder townships are well nigh entirely formed of Pocono sand, and so little farming is done in these townships, that no study was made of them. On the road from Coalport to Albrights, in Kidder township, are a number of isolated farms and some good crops are raised, especially the grasses referred to in the discussion of Packer township. Corn, potatoes, oats, buckwheat and some rye are also raised. What seems to deserve a thorough investigation in this section, is the possibility of converting some sections of this enormous acreage, now producing little in the way of forest, into grazing lands for raising the hardier grades of cattle and sheep. With the markets to consume all that can be produced on account of the coal fields in this county, every acre of available land should be used for producing short season crops and animal and dairy products. The Lehigh Valley, the Central of New Jersey, the Lizard Creek, the Chestnut Ridge from Palmerton to Kunkelton in Monroe county are the R. R. systems of the county.

MONROE COUNTY

On the first day of April, 1836, the county of Monroe was formed. It contains 398,720 acres, of which 204,007 acres is land in farms, and of which 97,298 acres is improved farm land. 9,387 acres were planted with corn in 1909, yielding 229,924 bushels; 7,567 acres were sown with oats, yielding 143,177 bushels; 1,444 acres were sown with wheat, yielding 23,519 bushels; 5,893 acres were sown with buckwheat, yielding 89,410 bushels; 10,185 acres were sown with rye, yielding 105,213 bushels; 2,394 acres were planted with potatoes, yielding 127,153 bushels; 17,883 acres were sown with all forage crops, yielding 18,080 tons of the various kinds of hay. Of the 97,298 acres of improved farm land, 65,871 were used for raising farm crops, while 92,575 were not so used and were likely producing weeds. At this time Monroe county had a population of 22,941 to feed, 10,936 cattle, 4,084 horses, 88 mules, 7,185 swine and 2,413 sheep.

This county lies south of Pike and south of Wayne counties and north of Northampton, with the Delaware River forming the boundary between it and the State of New Jersey. The geological strata,

together with the glacial drift, from which the soils of the county are derived, begin with the Medina sandstone and the Oneida conglomerate which makes up the Blue Mountain and forms the boundary between this and Northampton county and extends through the Clinton red shale, the Lower Helderberg limestone, the Oriskany sandstone, the Caudagalli grit, which, wherever it occurs, forms ridges and little of it enters the formation of the soil—the Upper Helderberg limestone, the Marcellus black shale, the Hamilton flags, the Genesee black slate, the Chemung flags, the Catskill red sandstone, the Pocono sandstone, the Mauch Chunk red shale and the Pottsville conglomerate.

MIDDLE SMITHFIELD TOWNSHIP

This township occupies the northeastern part of the county with the Pike county line for its northern and the Delaware River for its eastern boundary.

Along this township the Delaware River, which forms the boundary between it and New Jersey, flows on the Clinton shale, though it is seldom seen outcropping in or along the sides of the drift filled valley in which the river flows and therefore does not take part in the formation of the soils along the river, which are derived from glacial and alluvial materials brought down by the river, and deluvial additions from the hillsides.

Where the valley is sufficiently wide, among the best trucking soils any where in the State occur; because they are sufficiently sandy to be cultivated early and sufficiently fertile and warm, with thorough cultivation and manuring, to cause quick growth of early vegetables so that with good management several crops can be gotten off these lands in a season. These soils are also well adapted for raising crops for the dairy. By raising a somewhat earlier maturing corn crop, the corn land can be sown with rye and winter vetch and these can be made into silage in the spring and the land planted with the soja bean and the soil prepared and sown with alfalfa to the raising of which the more elevated of these soils are well adapted. The soils, as previously stated, are derived from glacial drift which fills the valley and are deep with splendid water and fair fertility holding capacity. They are easily farmed and will produce all agricultural crops successfully that thrive in this section.

In some places the valley is narrow and little of this farming land exists but whether narrow or wide, immediately north of this valley the Lower Helderberg limestone makes the steep slope of the hill with a soil derived from the underlying limestone and glacial drift. The slope is usually steep, with fairly deep soils that range from stony to gravelly into the loamy type, with fair water and fertility holding

capacity and, except during excessive rain falls or in places where the slope is very steep, does not wash, especially not when hillside farming is practiced.

Much of this limestone hillside is in forest or is used for pasturing; but wherever the steepness is not excessive, or upon the terraces of which there are a number, the land is farmed and produces fair crops of corn, rye, buckwheat and the clovers. Alfalfa yields larger crops of hay along these slopes and terraces than any of the other clovers or hay grasses, and if it had no soil improving capacities it would pay to raise this crop simply for its yields, but when its soil improving capacities are considered the growing of it becomes a duty.

The following analysis give the composition of some of the limestone in this township. From Ivan Auken's Quarry:

2nd. Pa. Geo. Survey C5, Page 142.

	No. 3.	No. 4.	No. 5.	No. 6.
Carbonate of lime, ...	82.732%	93.267%	93.875%	88.821%
Carbonate of magnesia, .	2.830 "	1.384 "	1.309 "	2.345 "
Oxide of iron and alumina, ...	0.136 "	0.840 "	0.680 "	0.710 "
Sulphur, ...	0.695 "	0.113 "	0.153 "	0.207 "
Phosphorus, ...	0.007 "	0.010 "	0.010 "	0.013 "
Insoluble residue, ...	11.930 "	4.250 "	3.920 "	7.650 "
	98.330%	99.864%	99.949%	99.746%

The following analysis give the composition of the limestone in limestone ridge opposite Poxono Island:

	No. 1	No. 2
Carbonate of lime, ...	90.178	89.392
Carbonate of magnesia, ...	4.313	3.254
Oxide of iron and alumina, ...	1.10	1.260
Sulphur, ...	0.251	0.267
Phosphorus, ...	0.010	0.013
Insoluble residue, ...	3.610	5.940

Abid G5, Page 147.

Along the brow of this hill, facing the river, the limestone outcrops in many places and could be ground on top of the hills and applied to the soils as ground limestone, wherever necessary without much difficulty, by sledding it down the hill.

The soils along this brow and in many places for some distance northward are derived from the underlying limestone and drift material and are fertile and will produce well, as is evident from the large and vigorous white oak trees that have been, and are still in a

few places, growing on these soils. North of this Limestone Ridge the Oriskany sandstone outcrops but makes so little showing that it need not be considered as entering the structure of the soil. Following northward comes the Caudagalli grit, which forms the Northern slope of Walpack Ridge. On top of this ridge are many sections where the limestone and the limy formations of the underlying rock enter into the formation of the largely drift derived soils, and wherever this is the case, large white oak trees thrive and blue grass finds congenial soil conditions. Apple trees make a vigorous growth and produce a well colored, nicely flavored fruit in all sections where the sandy formation has yielded sufficiently to the agencies of disintegration and to glacial action and where sufficient glacial material remains to form, together with the disintegrated underlying rock, a comparatively deep soil.

North of Walpack Ridge, in the old Burned Valley the soils are derived in some places partially from the Upper Helderberg limestone and the glacial drift, with occasional additions of the underlying Marcellus limy shales and some sandstone from the Hamilton strata immediately north of the valley. Throughout this valley are some moderately rolling sections with deep soils with fairly large water and fertility holding capacity adapted to raising all crops that thrive under the prevailing climatic conditions. Canada field peas and oats thrive and produce large crops. Alfalfa is being raised successfully in several places throughout the valley. Potatoes produce very satisfactory returns. Corn, rye, wheat and buckwheat yield paying returns, especially flint corn, rye and buckwheat. In the limy soils, wheat, clover and potatoes yield inviting returns, and wherever these soils occur a rotation of clover, potatoes and wheat should be adopted. The sandy soils, like those previously discussed along the river are adapted for trucking.

North of this drift filled limestone and Marcellus shale valley, the Hamilton sandy strata make high bluffs and sometimes cliffs; while in a general way above these steeper formations where the Genesee strata prevail, a comparatively broad shelf of fairly good soil, derived from glacial drift, Genesee and Chemung debris, adapted for raising the hay grasses, rye, oats, potatoes and with the application of lime and phosphoric acid, will produce the clovers. These soils are usually rough and stony and difficult to farm, and the crops, when produced, are difficult to harvest and get to market and, therefore, wherever this is the case the land should be reforested or allowed to remain in forest.

The Chemung ridge, north of the Genesee, is still rougher than the more moderately sloping Genesse formation and, therefore, less adapted for farming. The remainder of this township is underlaid with the Catskill strata and is so deeply covered with drift material

that it is difficult to determine whether the underlying rock except along the Chemung hills, can be considered in the formation of the soil. Bear, Long and Kennard Swamps cover a large part of the northern and western part of this township, leaving only a small area, here and there, adapted for farming.

SMITHFIELD TOWNSHIP

This township lies southwest of Middle Smithfield with the Delaware River making the dividing line until it turns southward through the Blue Mountains, and the crest of this mountain becomes the dividing line between it and Northampton county. The underlying strata from which, together with the glacial drift, the soils of this township are derived are, with a few exceptions the same as those of Middle Smithfield.

The Delaware River bottoms are similar to those in Middle Smithfield township with similar soils and similar adaptations. The Lower Helderberg limestone continues to form the strata on the slope along Walpack Ridge facing the Delaware River until the river changes its course southward at the mouth of Broadhead Creek and the limestone ridge becomes the southern slope of Godfrey's Ridge overlooking the Cherry Creek Valley. The fairly broad undulating Cherry Creek Valley with deep, large water and fertility holding capacity soils is among the richest farming sections of the county. This is a splendid dairy and market gardening district and the soils in this section should be utilized for both these purposes because the summer boarding houses and the hotels will furnish a good market for all the vegetables and dairy products during the summer months, and the larger cities, which are easily accessible for dairy products during the whole year but especially during the winter.

North of the Cherry Creek Valley and the limestone ridge, above referred to, along the southern bank of Broadhead Creek, is a ridge of hard sandstone which makes rough land; but wherever the soil is sufficiently clean, the underlying rock, which are limy, had a salient influence in the formation of the soil all of which is demonstrated by the trees and vegetation which thrive here. In the vicinity of East Stroudsburg and Experiment Mills, the Upper Helderberg limestone has entered more largely into the formation of the soils than in any section of the county.

The following gives the composition of some of the limestone that has been burned into lime:

Carbonate of lime, ...	89.014
Carbonate of magnesia, ...	0.915
Oxide of iron and alumina, ...	0.380

Sulphur,	0.056
Phosphorus,	0.012
Insoluble residue,	9.860

G6, Page 118.

These soils are fertile and easily farmed when compared with many soils that are farmed in Monroe county. Corn, wheat, oats, Canada field peas and alfalfa thrive in these soils and with good farming will produce inviting returns. Northward along Marshall Creek the land becomes more hilly and apparently, from the crops, less fertile. Land where the soil is deep produces fruit, especially apples of richer color and more delicate flavor than the more fertile soils further south and, therefore, wherever possible, the less steeply hilly sections should be used for the production of this fruit. This same hilly condition with similar soils as previously described continues northeastward between Marshalls and Shawnee Creeks until the Upper Helderberg is reached.

A long high sandstone ridge, ending in Mosier's Knob extends between Shawnee Creek and the Delaware River with soils very similar to those between Marshalls and Shawnee Creeks, and with similar adaptations. From Mosier's Knob 1175 A. T., a view of the Delaware River Valley and the country north and south of it is obtained not equalled anywhere in the county. Along the Shawnee the Lower Helderberg outcrops in a number of places and beneficially influences the soil. North of the rough and hilly country containing some deep apple soils the underlying, more easily disintegrated Upper Helderberg limestone and the Marcellus shales have made possible the formation of an undulating valley throughout the course of which are many outcroppings of the limestone, which mix to some extent with the glacial debris that fills the valley, in the formation of the soil, making it more productive and more permanently fertile than it would otherwise be. North of this valley the Hamilton sandstone forms the hills and makes a country with poor soils difficult to farm. Chemung and Catskills, which occupy the northern corner of the township, makes a hilly country with little farming land.

STROUD TOWNSHIP

This township lies directly west of Smithfield with the crest of Kittatiny or Blue Mountain forming the boundary line between it and Northampton county to the south of it. The geological strata, underlying the township and which, together with the glacial drift, form the soil are the same as those of Middle Smithfield township previously referred to.

Cherry Creek Valley continues through this township widening in the western part. Here, as in its whole course, it is filled with drift material and at the exit of Mountain Run and vicinity, with large limestone bowlders, evidently derived from the Lower Helderberg limestone ridge, which makes rough land and farming operations are attended with difficulty; while westward from this place the land, though hilly except in the valley, is smoother, more fertile, with deep soil having large water and fertility holding capacity, adapted to raising all the regular farm crops that thrive in this section. Walpack's or Godfrey's Ridge, composed of the Lower Helderberg limestone, continues through this township with soils derived of both drift material and the underlying limestone. These soils are naturally fertile and, except where the slopes are too steep, can, by practising hillside farming, be profitably farmed, especially if such crops as alfalfa, rye and other soil holding crops are raised.

North of Godfrey's Ridge, in McMichael's Creek Valley, the Upper Helderberg limestone is exposed and sometimes takes part in the formation of the soil. At Stroudsburg and extending to East Stroudsburg the underlying, easily disintegrated limestone and Marcellus shales have made possible a broad and nicely rolling plain covered with drift with deep easily farmed soils having large water and fairly good fertility holding capacity, adapted to raising trucking and dairy crops.

The Hamilton sandstone makes a ridge through this township with hilly and stony land, though covered with drift materials it is of little value for agricultural purposes. The more easily disintegrated Genesee slates make possible the formation of a valley between the Hamilton sandstone, previously referred to, on the south and the hard Chemung strata on the north in which occurs some better farming land. The Catskill red shale comes up in the northern end of this township and, being more readily acted on by the agencies of disintegration, makes a less steeply hilly country with better and more easily farmed land.

HAMILTON TOWNSHIP

Hamilton townships lies immediately west of Stroud, with the crest of the Kittatinny or Blue Mountains forming the boundary between it and Northampton county. The widened Cherry Creek Valley extends into this township and some of the easily disintegrated Clinton red shale, which has made possible the excavation of this valley, crop out. The Lower Helderberg limestone continues forming the slope along the northern side of the valley, and is known further south where the limestone does not outcrop, as Saylorsburg Ridge while previously it was Godfrey's and Walpack's Ridge. This ridge

curves southward approximately two miles from the eastern boundary of the township, and by this curving reaches the center of the widened Cherry Creek Valley spreading over quite an extensive area in the vicinity of Bassardsville, where in previous years from the extensive quarries it must have been burned into lime more extensively than anywhere else in the county.

The following analysis represent the composition of the stone in this section:

	No. 1	No. 2
Carbonate of lime, ...	94.285%	87.928%
Carbonate of magnesia, ...	1.528 "	1.937 "
Oxide of iron and alumina, ...	0.700 "	2.110 "
Sulphur, ...	0.056 "	0.229 "
Phosphorus, ...	0.014 "	0.019 "
Insoluble residue, ...	2.850 "	7.860 "

Pa. 2nd. Geo. Survey G6, Page 142.

In this section the limestone also enters into the formation of the soil along both sides of the ridge more extensively than elsewhere. The Oriskany sandstone makes a more formidable ridge in this township than any of the townships previously discussed. The land is hilly, rough and stony with, however, some limited smoother sections with comparatively deep soils in which apple trees grow thriftily producing large yields of a well colored nicely flavored fruit.

The Upper Helderberg limestone outcrops to the north of this ridge, but it is so flinty that when burned into lime it does not slake. Toward the western extremity of this township it disappears not to reappear in this county. McMichael's Creek flows in a valley carved out of the Marcellus shales, now deeply buried with drift material, with small sections of deep soils adapted for raising all agricultural crops that will thrive in this county. North of this valley the harder Hamilton sandstone forms high ridges and hilly land little of which is adapted to farming.

ROSS TOWNSHIP

This township lies west of Hamilton, bordering on Northampton county. Cherry and Aquanchicola Creeks rise on a low divide in the buried valley between the Blue Mountains and the Oriskany Ridge in this township from which Cherry Creek flows northeastward and the Aquanchicola flows southwestward. This low divide covers a considerable acreage most of which needs underdraining to make it produce up to its capacity; and a drainage system including a number of farms should be planned and built by the combined efforts of the farmers. North of the Oriskany Ridge, in a drift filled valley, another extensive swamp occurs in which Frantz's Creek

rises and flows west and McMichael's Creek flows eastward. All this land could be drained and converted into farming land which it seems would make the most valuable soil in the township.

The terminal Moraine passes through the eastern part of this township, with great drift heaps, mounds and ridges in many instances more than a hundred feet high. On the more rolling sections of this terminal Moraine are some fertile easily farmed soils adapted to the raising of all agricultural crops that will thrive under prevailing climatic conditions. Beside the glacial drift, which covers only the northern part of this township, the soils are derived from the Oneida conglomerate, the Clinton shale, the Lower Helderberg limestone, the Oriskany sandstone, the Marcellus black shale, the Hamilton, the Chemung and Catskill.

The valley of Aquanchicola Creek is carved out of the easily disintegrated Clinton red shale which is, however, largely covered up but effects the composition of the soil in a saliant way. The Lower Helderberg limestone has been quarried quite extensively west of Saylorsburg and burned into lime for agricultural purposes. West of this place is the low divide which has soils that are very much benefited by lime. The Oriskany sandstone, as previously indicated, forms a ridge through this township, known as Dodendorfs Mountain, which rises to a height of 1,200 feet A. T. and has been so extensively broken up by the agencies of disintegration that the crest and both sides are covered to great depth with rocks and gravels derived from this material. In a few places some limy materials evidently occurs in this formation which has been sufficiently decomposed to form fertile soils along this mountain. North of this mountain the swamp, previously referred to occurs, and south of this the valley of Frantz's Creek, on the Marcellus shales north of which the softer Hamilton rock form the basis of some farming land. Summit or Wire Ridge makes a hilly and rough country on the northern border of this township with little farming land.

ELDRED TOWNSHIP

This township occupies the southwestern part of this county, having the Northampton county line for its southern and Carbon county for its western boundary. The Aquanchicola Creek continues flowing on the Clinton shale at the foot of the Blue Mountains with similar soils previously discussed. The soils of the northern slope of the Blue Mountains, which has been referred to in the discussions of every township south of the Delaware Water Gap, are derived from the Oneida conglomerate and the Medina sandstone. This slope is usually steep, rough and stony, with only here and there soils that are suited for farming or for fruit raising; but wherever these soils

occur they are deep, with large water and fairly large fertility holding capacity, adapted for raising such crops as buckwheat, rye, potatoes, and when limed, will produce the clovers. Apple trees make a fairly vigorous growth and produce fair crops of good size well colored fruit.

Near the northern border of the township is a broad level valley with some nicely rolling land with soils derived from the disintegrated rock from the surrounding hills and mountains and the underlying strata. Otherwise the soils are very similar to those of Ross township except that the Catskill rock makes the basis of a broad belt about one mile wide in the northern part of the township with some fairly fertile sections, and that the slopes along the streams are steeper, and in many instances, gorge like.

POLK TOWNSHIP

This township lies north of Eldred with the Carbon county line for its northern and western boundaries. The strata underlying this township range from the Marcellus to the Catskill Wire Ridge, from 1,000 feet—1,100 feet A. T., runs along the southern boundary, capped with the Catskill, while the Chemung beds make the northern face of the mountain forming rough land of little agricultural value.

Big Creek in the vicinity of Kresgeville and east and west of this place and throughout the valley, good farming land occurs adapted to raising the hay grasses such as timothy, oats, rye and buckwheat; potatoes yield average crops while, where the underlying Hamilton shales enter the formation of the soil and the land is well farmed, the clovers, the red, the alsike and in all probability alfalfa would thrive. North of this valley and extending to the foot of Pocono Mountain, along the northern boundary of the township, the soils are derived from the underlying Catskill and drift material making apple, timothy hay, oat and potato soils.

CHESTNUT HILL TOWNSHIP

Chestnut Hill township lies east of Polk, with Ross township on its southern border. Wire Mountain, of hard Chemung rock, extends along the southern line of this township, the same as Polk, while Pocono Mountain forms the northern boundary. An ancient drift filled valley extends east and west through this township connecting with the valley referred to in Polk township with soils derived from the same underlying strata together with the drift materials adapted to raising the same crops.

At Broadheadsville and its vicinity the soils are fairly fertile, being formed from the more easily disintegrated Hamilton shale and drift materials. The same is true of the Catskill soils north of this valley.

JACKSON TOWNSHIP

Jackson township lies east of Chestnut Hill township with Hamilton on the south and Pocono on the east of it. The Hamilton shales which underly the southwestern and southern part of this township make a less hilly country than the Chemungs which form a high ridge in the eastern part of the township with rough land which extends through the township to and beyond the western extremity. North of this Chemung ridge and along the base of Pocono Mountain, underlaid with Catskill and covered with drift material, a wide level plain extends east and west through this township with some fairly fertile land adapted to raising hay and pasture grasses.

POCONO TOWNSHIP

This township lies east of Jackson and north of Stroud townships. Pocono Mountain, which forms the northern boundary of the townships, projects into the western part of the township and makes a high bluff, rising almost vertically 1,000 feet above Pocono Creek flowing at its base, and makes a hilly and even mountainous country in the western part of this township with soils of little agricultural value. Further south and east the land becomes more rolling with soils derived from glacial drift and the Catskill red sandstone adapted to farming and apple raising.

PARADISE TOWNSHIP

Paradise township lies northeast of Pocono and west of Price. This township, like Pocono, has Pocono Mountain on its western boundary, which here makes rough mountainous land little of which can be farmed. East of this mountain in the central, eastern and southern part of the township, through Paradise Valley, is some rolling land, with fairly deep soils, with good water and fertility holding capacity, derived from glacial drift and the underlying Catskill strata adapted to raising the hay grasses such as timothy, and among the grains oats, rye, barley and flint corn. Flax, it seems could be made a profitable crop, so could Canada field peas and alsike clover and among the fruits apples.

PRICE TOWNSHIP

Price township lies east of Paradise and west of Middle Smithfield. The land along Broadhead Creek is hilly and usually not adapted to farming. Other sections are similar to the townships previously discussed with soils derived from the same materials.

BARRETT TOWNSHIP

Barrett township occupies the northeastern corner of the county with the Pike county line for its northern boundary. This township is deeply covered with drift materials, with soils derived from it which are, in many places, sufficiently rolling to be easily farmed but are stony and thin and poor.

COOLBAUGH TOWNSHIP

This township lies west of Barrett and Paradise, with the Pike and Wayne county line for the northern boundary. The elevations A. T. in this township vary between 1,586 and 2,160 feet. At such elevations above the surrounding country one would presume that the land would be free from swamps and bogs, which, however, is not the case for a large part of this township is covered with bogs and swamps, and the parts not so covered, except the eastern section, are covered with large boulders of glacial debris in such numbers that farming is largely impossible. It seems that with some assistance from the Department of Agriculture of the State, in the way of demonstration work, that this swampy land could be converted into cranberry marshes and make a profitable agricultural industry.

TOBYHANNA TOWNSHIP

Tobyhanna township lies south of Coolbaugh. The soils of the township are derived from the glacial drift. The elevations above tide in this township vary from 1,500-1,900 feet. The surface is not swampy, but sandy, and in some places covered with large boulders, and large sections could not be farmed. The soil is usually thin and poor and with the cool nights and short seasons usually prevailing, only such crops that can thrive under adverse conditions can be successfully grown in this township.

TUNKHANNOCK TOWNSHIP

Tunkhannock township lies directly south of Tobyhanna on the Carbon county line. The soils are derived from glacial drift, which spreads over the entire township. Tunkhannock Creek rises in the northeastern corner of the township and flows sluggishly through the south central part where it spreads northward and forms what is known as "Long Lake" about three miles in length along the borders of which are several cranberry marshes in which this berry grows successfully.

The county is drained southward into the Delaware River by Shawnee Pond, Marshalls, Brodhead, McMichaels, Pocono and Cherry creeks, and westward into the Lehigh River by Aquanchicola, Frantz's, Pohopoco—or Big Creek—Tunkhannock, Tobyhanna and Tunkhanna creeks. The railroad facilities of this county are good.

PIKE COUNTY

Pike county was taken from Wayne by Act of March 26, 1814. It contains 348,160 acres, of which 173,481 acres is farm land, and of which 26,407 acres is improved farm land. 1,651 acres were planted with corn in 1909, yielding 41,315 bushels; 1,242 acres were sown with oats, yielding 24,856 bushels; 122 acres were sown with wheat, yielding 2,089 bushels; 1,452 acres were sown with buckwheat, yielding 22,646 bushels; 1,449 acres were sown with rye, yielding 16,040 bushels; 735 acres were planted with potatoes, yielding 60,566 bushels; 6,882 acres were sown with all forage crops, yielding 7,423 tons of various kinds of hay. Of the 26,047 acres of improved farm land, 13,533 acres were used for raising farm crops, while 12,514 acres were not so used and were likely producing weed. At this time Pike county had a population of 8,033 to feed, 4,527 cattle, 1,343 horses, 52 mules, 1,751 swine, and 1,335 sheep.

THE SOIL FORMATIONS OF PIKE COUNTY

Pike county begins, geologically, with the Upper Helderberg or Carniferous limestone and ends with the Pocono sand in the western part of Greene township on the western border of the county, or its soils are formed from the disintegrated rocks of the Upper Helderberg lime, the Marcellus, Hamilton, Genesee and Chemung shales, together with glacial drift and alluvium, along the Delaware River, while, with the exception of this narrow strip, the whole of the county has a rolling, hilly surface of Catskill red and grey sandstone, covered with a sheet of glacial drift many feet deep in places, while at others the gray and red Catskill cover the surface completely though effected by glacial action.

The soils of Lehman, Delaware, Dingman, Milford and Westfall townships along the Delaware River, are all in the same geological formations, the Marcellus, Hamilton, Genesee and Chemung shales and the Catskill sands back of the upper edge of the Chemung formations.* These townships have a large acreage of alluvium and limy Marcellus soils along the river as for instance at Egypt Mills in Lehman township where Toms Creek flows into the Delaware, at Delaware and in the vicinity of Dingman's Ferry at Broadheads or at well nigh all points where the river curves westward, this soil accumulation has occurred and the most fertile soils of the county have been formed. These soils will produce all crops that grow under the climatic conditions that prevail here; but they are in a special way adapted for trucking or market gardening and a large acreage should be utilized for growing these crops, because these soils can be prepared early.

*For a fuller discussion of the soils along the river, see Monroe County.

They do not become cold and water lodged and can be worked easily soon after rains and do not become compacted, and the summer hotel trade in this section will gladly consume all that can be raised here for sometime and if there should be a surplus, large cities are not beyond reach. These garden crops could be so arranged that they would be ready for the trade during June, July August and September and with a co-operative cannery to use any surplus, this could be made a business that would bring summer boarders in larger numbers because with the right kind of treatment vegetables of a superior type can be raised here.

But why not have a garden seed farm or several of them in this section and raise northern garden seeds of a superior type, which these soils will produce as well as any that exist anywhere in the State or any other state. The cereals will do equally as well here as any other crops. In fact one farm along the renowned road, always in good condition, in all kinds of weather is called a "wheat farm" and deserves it. A rotation of wheat and clover and corn could easily be practiced here. Alfalfa also thrives in this soil and can easily be raised. Porter, Blooming Grove and Shohola townships are largely controlled by an organization, called the Blooming Grove Hunting and Fishing Club. Through the efforts of this club roads have been built, so that these interior townships of the county can be easily reached from Milford, the county-seat, or from such places as Hawley, and farmers can get their products to market by teaming.

Some of the creek valleys of these three townships are farmed and produce large crops of hay. The valley of the Blooming Grove Creek and its branches are among these. At Westbrooke, in Blooming Grove township, years before turnpikes were built five roads came together such as the Wyoming Road, the Wilderness Road, the Shohola Road, etc. Land was cleared and farmed and is farmed at the present time, by the descendants of the same people who cleared it. The soils of the meadows along these streams are usually a tough clay, hard to farm and, therefore, should be put into good physical condition by a large application of lime, manure and phosphoric acid and sown with timothy of which crops of hay can usually be raised and allowed to remain in sod as long as paying crops are produced. A large part of the three townships, referred to, as well as parts of the western parts of Lehman, Delaware, Dingman, Milford and Westfall are underlaid with a well nigh impenetrable hard-pan, the effects of which are evident in the stunted timber growth and the scrub-oak, ground and scrub-pine. This land should not be farmed when thousands of acres of easily and a profitable tillable land is not used.

GREENE TOWNSHIP

Greene township, in the western corner of the county, has a larger acreage of Pocono sand than all the remaining townships, and at Greentown and vicinity, across the Paupack Creek, from Dutch Flats, is one of the largest farming sections in this part of the State. The soils here are formed from glacial drift and the disintegration of the native red Catskill rock, and as is usually the case, are better adapted for raising the cereals, especially wheat and rye, than the gray Catskill and more grain is raised here than is usual in this section of the State. A rotation of grass, corn, oats, rye and grass or grass, corn, oats and grass, with sometimes, potatoes and buckwheat in the sod instead of corn. It seems that here, away from R. R., rotations should be arranged for raising crops that can be converted into the manufactured products on the farm, such as butter, meats and eggs, etc., and retain as much of the fertility on the farm as possible.

Parts of Greene, Palmyra, and Lackawaxen townships are in the natural apple and hay belt of the State. Here, apple trees grow in sufficient numbers to begin an apple orchard without planting. Those who are going into the fruit raising business, frequently simply top graft these natural trees and in this way in a few years have an orchard bearing, which would take at least ten or more years if the trees had to be grown. These wild or natural trees respond equally as well to good treatment as do the cultivated and are less ameniable to diseases. The Delaware River forms the boundary along the eastern line of the county and New Jersey. The Misthope, Lackawaxen, Shohola, Little Pond, Bushkill, Sawkill, Frenchtown, Brand, Dingman, Conashaugh, Egypt Mills and the Bushkill Creeks drains the county. Numerous lakes and ponds are distributed over the county some of which, have dried up and are now swamps and some muck swamps which could be made into celery and vegetable gardens. The Erie Railroad enters the county at Hawley, and the Delaware, Lackawanna and Western Railroad has accessible stations in Monroe and Lackawanna counties.

LUZERNE COUNTY

By an Act of the 25th of September, 1786, Luzerne county was established and named in honor of Charles Dela Luzerne, Minister of France to the United States. This county embraces the territory upon which the Wyoming Massacre occurred. It contains 570,880 acres, of which 269,486 acres is land in farms, and of which 137,778

acres is improved farm land. 11,762 acres were planted in corn in 1909, yielding 261,247 bushels; 11,112 acres were sown with oats, yielding 249,828 bushels; 3,475 acres were sown with wheat, yielding 60,230 bushels; 6,326 acres sown with buckwheat, yielding 70,411 bushels; 9,248 acres were sown with rye, yielding 114,806 bushels; 5,833 acres were planted with potatoes, yielding 452,763 bushels; 31,093 acres were sown with all forage crops, yielding 35,687 tons of the various kinds of hay. Of the 137,778 acres of improved farm land, 78,849 acres were used in raising farm crops, while 58,929 were not so used and were likely producing weeds. At this time Luzerne county had a population of 343,186 to feed, 16,062 cattle, 6,558 horses, 412 mules, 9,562 swine and 2,934 sheep.

Luzerne county lies north of Schuylkill and Monroe counties, south of Wyoming and east of Columbia and Sullivan. The outcropping rock strata from which, together with the glacial drift, the soils of this county are formed begin with the rocks of the coal measures and extend down to the Chemung formations. This county has more mineral wealth in its coal deposits than any county in the Anthracite coal field, except Schuylkill. It has markets for all farm products equal to any anywhere in this country or for that matter equal to any markets in the known world.

The North Branch of the Susquehanna River forms the boundary between this and Lackawanna county, from Wyoming county to Pittston, from where it curves southwestward, flowing on the glacial drift with which its bed has been filled, thence on the Mauch Chunk red shale to Shickshinny where it curves southward to the Wapwallopen from whence it flows southwestward to Nescopeck where it leaves the county. It and its tributaries drain all of the county except the southeastern section. The terminal Moraine enters the county in this southeastern corner, passes up Sand Run Valley over Hell Kitchen Mountain, across Conyngham Valley and Nescopeck Mountain and down the river to Berwick in Columbia county.

Western Foster, Hazel and southern Black Creek townships form the southern border of this county. In these townships are located the eastern and middle coal fields with between five and six hundred feet of coal measure rock surrounded on all sides with Pottsville conglomerate, which contains little farming land. On the coal land and shales, some farming is done and all encouragement should be given these efforts, because here is a section of country with a large consuming population in such towns as Hazleton, in Hazle township, which had over 25,000 inhabitants in 1910. The coal sand and shales form a soil that will produce truck crops when fertilized with manure, which can be obtained from the surrounding towns, where on account of the mining idustry, large numbers of mules and horses are used.

DENNISON, BUTLER, SUGAR LOAF AND NORTH BLACK TOWNSHIPS.

These townships have soils formed from the conglomerate and the Mauch Chunk red shale. Where the conglomerate and the Mauch Chunk mix, the soils are extremely rough, and poor in some places that trees do not grow, not even scrub-oak. Whether this has been caused by frequent burning over of this soil I was unable to ascertain; but poor they certainly are. Such a section occurs from Conyngham Pass to Hazelton. Here is a moderately rolling stony and rocky upland on which little is growing, and it seems a barren waste but upon which evidently from some stumps still remaining a forest must at sometime have grown.

Passing from the conglomerate into the Mauch Chunk red shale in the Conyngham Valley in the vicinity of the towns of Conyngham and Seybertsville, in Sugar Loaf township, the whole scene is changed. Here is a moderately rolling formation of soils composed of glacial drift and the underlying Mauch Chunk shale of good productive capacity and easily farmed. When this examination was made corn was growing here equal to that of the supposedly more fertile Catskill formations in the surrounding townships. This valley formation extends from western Butler to eastern Black Creek township. Intensive farming should be encouraged here because of the demands for all farm products in this immediate vicinity. Potatoes, tomatoes, cabbages thrive here and among the fruits apples.

Nescopeck Mountain, of Pocono sand, forms the dividing line between these southern Mauch Chunk red shale and coal measure townships and the Catskill and Chemung formation townships, between Nescopeck and Lees Mountain farther northeast, known as Wyoming Mountain.

WRIGHT, SLOCUM AND DORRANCE TOWNSHIPS

Wright, Slocum and Dorrance townships occupy the eastern section of the county between Nescopeck and Wyoming Mountains. The soils of these townships are formed from glacial drifts and the disintegrated underlying Catskill and Chemung rock strata. The big Wapwallopen Creek, coming in from Lackawanna county, flows westward through these townships, while the Little Wapwallopen, which rises in the northern part of Wright township also flows westward over similar formations into the Susquehanna River.

In the eastern part of Wright township, on its Catskill shales and drift, are some moderately rolling, fairly fertile agricultural soils, somewhat rougher than the Catskill soils usually are, but from the appearance of the trees well adapted to apple growing and evidently should be planted with this fruit. In these townships, even with the overlying glacial drift, is demonstrated in a striking way

the effect of harder and softer rock on the topography of the country. The harder Chemung rock form a more hilly country with rougher and more stony soils while the Catskill, though running along with the Pocono sandstone form a more moderately rolling country. The same is true of the Hamilton formation.

HOLLENBACK, SALEM AND NESCOPECK TOWNSHIPS

These townships occupy the western section of the county south of Lees Mountain. Hollenback township lies west of Slocum and Dorrance and south and east of the Susquehanna River. Its rock strata extend from the coal measure rocks down to the Hamilton formations and contain more than 10,000 feet of geological strata. The northern part of this township is very rough and little of any agricultural land exists; but after the river breaks through Lees Mountain and strikes the Catskill shales, though these are covered with drift materials and are hilly, here some farming is being done.

At Wapwallopen, on the Hamilton shales, the valley widens and forms a beautiful farming section, extending eastward beyond the limits of this township into Dorrance township. South of this valley the harder Chemung shales again form a more hilly country which gives place to a more rolling section farther south on the Catskills. These soils will produce potatoes and the more agricultural of the trucking crops as well as the regular farm crops.

SALEM TOWNSHIP

Salem township lies west of the Susquehanna River, in the curve between Shickshinny and Wapwallopen. The geological strata of this township are approximately as extensive as those of Hollenback; but like those of Hollenback, are covered with glacial drift. But with all this, the effects on the fertility of the soil of the underlying strata are evident. Upon the soft Hamilton shales, along the Susquehanna River, is a rolling valley covering approximately the width of these shales. Northward of the Hamilton strata come the harder Chemung strata which make a ridge of considerable abruptness, upon which the softer Catskill form a broad valley, extending northward to the abrupt side of Lees Mountain, capped with the hard Pocono sandstone, which is rocky and stony and contains little or no farming land. The soils of this Catskill section will produce the regular agricultural crops.

NESCOPECK TOWNSHIP

This township lies south of the Susquehanna River and west of Hollenback. The rock strata in this township range from the Pocono to the Hamilton shales. These latter do not enter into the formation of the soil on account of the terrace deposits which form a high

bluff along the river. But the simple fact that the deposit remained here shows that these rocks had disintegrated to such an extent that this deposit could be made and maintained. South of this terrace deposit runs the harder Chemung ridge and above this a wide plain upon the Catskill strata extending south to the base of Nescopeck Mountain covered with the hard Pocono sandstone similar to Lees Mountain. These soils are not as productive as the eastern slopes of Lees Mountain. Apple trees look thrifty here and bear well.

NEWPORT, HANOVER AND WILKES-BARRE TOWNSHIPS

These townships lie north of Wyoming Mountain, largely within the Anthracite coal basin. The farming soil of these townships are largely located along the river and some of the moderately rolling formations some distance on each side of it.

From Mocanaqua northeastward, in Newport and Hanover townships, along the river, are soils of glacial drift and river alluvium, of splendid, fertility, especially adapted for market gardening, some of which is done here, but much more could and should be done to supply the enormous demand for these crops in the immediate vicinity in which are more than 100,000 people to provide for.

At Nanticoke and West Nanticoke, in Hanover township, are similar soils of even better productive capacity than those farther west and a larger acreage, because here the river valley is wider and the conglomerates do not extend as close down to the river and make the rough soils as they do farther west. This land should be protected in so far as possible from the accumulation of and from the coal mine slush and water.

WILKES-BARRE TOWNSHIP

In this township Wilkes-Barre, the county-seat of Luzerne county, is situated, with a population of 67,105. In the vicinity of this city the Lackawanna River Valley is about six miles wide, and here occurs the most extensive and fertile agricultural section of this county extending along both sides of the river for considerable distances.

Some market gardening is done here, but more could and should be done because of the great demand for these products and the high prices realized. This soil made of glacial drift and river alluvium is deep and moist, does not easily dry out, is sandy and warm enough to admit of early cultivation and is easily cultivated. Stable manure can be obtained from the surrounding cities and towns and the mines at very little cost to cover every acre of land in this section once every year which will furnish fertility and maintain the organic matter in the soil which will make it warm and dry in the spring and moist and cool in the summer. Exeter, Kingston and Plymouth townships have soils derived from similar rock strata.

EXETER TOWNSHIP

Exeter township extends from the curve in the river at Pittston northward along the river to the Wyoming county line. Its rock strata extend from the coal formations down to the lower Catskill strata. The small part of this township in the Wyoming coal basin, along the curve of the Susquehanna River at West Pittston, has already been described in the dscussion of Wilkes-Barre township.

The gorge of the Susquehanna, through Lackawanna Mountain and northward, and the wide valley in the softer rocks of the coal measures is a striking demonstration of the operations of disintegration in soft and hard rock strata. The Lackawanna Mountain rises from 1,200 to 1,300 feet above tide in this vicinity, while the river here is only from 500 to 600 feet above.

The Pottsville conglomerate, coming up from under the coal measures, make the mcuntain side rough and precipitous all along the eastern slope, while between it and the Pocono where the Mauch Chunk red shale outcrops and where all these intermingle are some soils adapted to farming and will produce well, such crops as potatoes, buckwheat, rye, oats and grass but seem to be especially adapted to apple raising. North of this mountain the Catskill shales and sandstones running down nearly to the top of the Chemung shales underlie the glacial drift and these, unless where this drift is too deep together form the basis of the soils. The land is hilly and some of it stony and not easily farmed but produces well.

KINGSTON TOWNSHIP

Kingston township lies west of Exeter and north of the river. It contains a larger section of the wide River Valley south of the Lackawanna Mountain than Exeter, all of which has already been referred to. The conglomerate rock forms the side of the mountain which here, as in Exeter makes a rough country with little or no farming land, while beyond, where, what is termed the Mauch Chunk red shale and the Poçono and the Upper Catskill intermingle, upland soils are formed that can be farmed and will produce the crops already named in Exeter township. In the Catskill and drift soils at such places as Shovertown, the land is hilly, and where the Catskill strata outcrop, stony, especially when these outcrops are the harder strata of this formation. This township, like Exeter, likely contains the whole of the Catskill strata.

Along the road from Wilkes-Barre to Dallas, north of the mountain, in the vicinity of Trout Brook, are some moderately rolling soils, adapted to all agricultural crops, but especially adapted for the pasture grasses, and the higher elevations for growing apples.

PLYMOUTH TOWNSHIP

Plymouth township lies west of Kingston and Jackson townships and has the Susquehanna River for its southern border. From Kingston, in Kingston township, to Plymouth in this township, and from there to the vicinity of West Nanticoke, is a splendid farming and market gardening section, probably the most fertile soil in this county, formed from glacial drift and alluvium. North of this part of the township the Pocono conglomerate makes a bold outcrop forming a mountain which rises from 1,250 to 1,400 feet above tide upon which there is little of any agricultural land. This mountain forms the boundary between Plymouth and Jackson townships. In the part of Plymouth township west of Jackson, in the vicinity of Mud Lake, are soils formed entirely from glacial drift, moderately rolling, and from the appearance of the crops, must be productive. In the vicinity of West Nanticoke, where the river curves upward and then westward, the land is moderately rolling, but soon becomes hilly along Shickshinny Mountain further west.

UNION AND HUNTINGDON TOWNSHIPS

These townships have similar underlying rock strata, all of which are represented in these soils. Union lies west of Plymouth and extends along the north bank of the Susquehanna River for a distance of five miles. The rock strata of the township extend from the base of the Anthracite coal measures down into the Chemung. The Pocono sandstone forms the ridge north of the river extending along the whole southern border of the township. There is not much farming land on either side of the river here and what is here is rough and stony and difficult to farm.

North of this ridge a branch of Shickshinny Creek, flowing parallel with the mountain, becomes sort of a dividing line between the big, hilly and more rolling country of this township. From here northward to Muhlenberg, along the stream and on the higher elevations on the Catskill shales and the glacial drift, are good agricultural soils, hilly but rather easily farmed. In the vicinity of Muhlenberg north, east and west of it the Upper Chemung strata appear in the soil formation; especially is this so in the northwest corner of this township. Here and further south, Chemung boulders are scattered through the drift material showing that this rock has taken part in the formation of the soils.

HUNTINGDON TOWNSHIP

Huntingdon township lies west of Union and has for its southern border Huntingdon Mountain. The rock strata exposed in this township begin with the Pocono on Huntingdon Mountain and extend

down into the Chemung strata. On the north side of Huntingdon Mountain 1,500 feet above tide, below the Pocono, the Catskill red strata cover the southern half of the township, while the Chemung rock cover the northern half. Glacial drift fills the valleys of the streams and covers the hills so that it is difficult to determine to what extent its underlying rock strata have shared in the soil formation. On account of this glacial action the hills though high are moderately sloping and can be farmed. At Harveysville, in the northeastern corner of the township, is one of these rolling sections as well as in the surrounding vicinity. Here is some evidence that the Chemung rocks have come into the formation of the soil.

The tier of townships running north of Huntingdon, Shickshinny and Lackawanna Mountains is well nigh in every way adapted for apple raising and with these a large acreage should be planted because of the adaptation of soil and climate the closeness to a market that will consume all that can be produced and the prices that can be obtained. It would make a more profitable undertaking carried on with less labor than any agricultural operation could be.

Wherever such conditions exist and where soil and climate are adapted to apple growing, it should be encouraged, while where soils and soil topography are adapted to agricultural crops these should be raised. Franklin, Dallas, Lake, Lehman, southern Ross and southern Fairmount have similar soil formations with the exception of the extreme southern part of Fairmount.

FRANKLIN TOWNSHIP

Franklin township lies west of Exeter and has Wyoming county for its northern boundary. This township has a more rolling formation than the township immediately north of the mountain and farming operations can be carried on more easily. The soils also are adapted to raising agricultural crops especially hay, oats, potatoes, corn, buckwheat and rye. Winter wheat, unless sown in soils too closely underlaid with hard pan, does well and it seems more should be raised. The rock strata with which this township is underlaid belong entirely to the Catskill formation.

DALLAS TOWNSHIP

Dallas township lies west of Franklin and has for its northern boundary Wyoming county. The rock of which in part of the soils of this township are formed belong to the lower Catskill strata. This township seems to be a moderately rolling tableland forming a divide between Toby Creek and the streams flowing north into Wyoming county. At Dallas, in the southern part, and at Kunkle, in the northern part of the township, the moderately rolling soils are well repre-

sented. This is one of the best farming sections of the county, overlaid with glacial debris. These are agricultural soils, well adapted for raising the crops already referred to in the description of Franklin township. The elevations range from 1,060 to 1,260 feet above tide.

LAKE TOWNSHIP

Lake township lies west of Dallas and borders on Wyoming county. The rock of this township belong to the Catskill and Pocono. The Pocono form the elevated summit of north mountain which extends through the northwestern corner. The Catskill cover all the township southeastward from this mountain. The same rolling formation described as occurring in Dallas township extends to all the country in the vicinity of Harvey Lake located in the northeastern corner of this township about which the glacier deposited enormous quantities of drift material. This is a splendid farming section, adapted to agricultural crops. Westward from this place the land continues about in the same condition as already indicated.

LEHMAN TOWNSHIP

This township lies south of Lake and west of Dallas. The Lower Catskill and probably in a few places the underlying Chemung strata, together with the glacial drift form the soils of this township. The land here is moderately rolling and easily farmed. Along Harvey's Creek the hills are smoothed down by the glacier and the deposits remaining here help still more to level the formation. The same thing occurs along Pike's Creek and in the vicinity of Three Cornered Pond. This is good farming land, well adapted to agricultural crops; is not stony, but rather gravelly, with some mucky low places where truck, such as celery and similar types of crops, can be easily raised for which there is a ready market.

ROSS TOWNSHIP

Ross township lies north of Union, with its northern border on the Lackawanna county line. The rock strata underlying the soils and the drift, are the Pocono the Catskill and the Chemung Catskill. The Pocono strata form the North Mountain which crosses the northern part of the township. The central section is an upland plain on which three ponds are located; North Pond, Grassy Pond and South Pond, all of which drain into Hemlock Creek.

Sweet Valley is one of the rolling agricultural sections of the township. In the vicinity of Bloomingdale, where likely the Chemung rock strata underlie the glacial debris, are soils easily farmed and of good fertility. In fact, the whole of the township from the North Mountain southward is one of the good farming sections of the county.

The northern part of the township is covered with Pocono rocks which form the crest of North Mountain, running east and west across the northern half of the township making poor soils.

FAIRMOUNT TOWNSHIP

Fairmount township lies west of Ross and along the Columbia and Sullivan county line. The Pocono strata form the North Mountain, which crosses the northern half of the township, upon which is located the elevated plateau extending northward into Sullivan and Wyoming counties. Otherwise the formations of the soil is very similar to that of Ross township except that it is more hilly.

This part of Luzerne county between North and Lackawanna Mountain is a hay, apple, potato and dairy section. From a 90 acre farm in this district an income of $3,400 was realized in one year from apples, hay and dairy products. There are thousands of acres of equal capacity throughout the county, from which an equal return can be made. A large number of dried up lakes and ponds exist in this district from which muck can be gotten to enrich more elevated soils or which can be used for truck crops.

Dairying should be encouraged because a large acreage of the soils of the county is well adapted for growing the farm crops such as the hay grasses and the clovers. The possibilities along these lines have only been touched. One farmer on the Catskill soils sold $1,800 worth of hay in one season and beside raised sufficient forage and the greater quantity of grain to feed 20 head of dairy cows.

WYOMING COUNTY

Wyoming county, taken from the northeastern corner of Luzerne, was formed April 4, 1842. It contains 254,080 acres, of which 169,031 acres is land in farms, and of which 107,423 acres is improved farm land. 4,430 acres were planted with corn in 1909, yielding 113,516 bushels; 5,236 acres were sown with oats, yielding 98,902 bushels; 461 acres were sown with wheat, yielding 7,197 bushels; 6,981 acres were sown with buckwheat, yielding 98,058 bushels; 2,549 acres were planted with potatoes, yielding 208,459 bushels; 27,359 acres were sown with all forage crops, yielding 34,408 tons of the various kinds of hay. Of the 107,423 acres of improved farm land, 49,465 acres were used for raising farm crops, while 57,958 were not so used and were likely producing weeds. At this time Wyoming county had a population of 15,509 to feed, 14,156 cattle, 3,499 horses, 76 mules, 4,350 swine and 6,475 sheep.

Wyoming county lies north of Luzerne, south of Susquehanna and east of Sullivan and Bradford. The outcropping rock strata from which, together with the glacial drift, the soils of Wyoming county are formed through glacial grinding and by disintegration, include the Pocono, Catskill (which cover more than two-thirds of its area) and the Catskill, Chemung, these latter occurring only in the northern section. The county is drained by the North Branch of the Susquehanna River which meanders through the county from its northwestern to its southeastern corner.

The tributaries flowing into the Susquehanna in this county are Meshoppen Creek, which drains a small area of northern Wyoming, Mehoopany Creek flowing into the river from the western section, drains a large part of the mountainous portion of the county. Bowman's Creek drains the south and southwestern section and Tunkhannock Creek the northeastern.

FALLS TOWNSHIP

Falls township occupies the southeastern corner of this county, having the Susquehanna River for its western boundary and Lackawanna county for the eastern. The glacial drift accumulated to such a depth that the course of Buttermilk Creek was changed from its ancient channel and it now falls into the river over a series of Catskill cliffs of a total height of 155 feet; while above these falls, the creek flows upon drift material so that the soils in this southeastern part of the township are derived from the glacial deposits. Some distance north of the mouth of Buttermilk Creek, in the curve of the river opposite the vicinity of Eaton, is a splendid farming section on the first terrace of the river, especially adapted to trucking, every acre of which should be used for these crops to supply the demand here.

The northeastern section of this township is more moderately rolling, similar to the land discussed in the description of Newton township, Lackawanna county. At Mill City and northward are clay soils especially adapted to raising the hay grasses, and it seems should be adapted to raising corn and the clovers because these soils seem sufficiently well drained for these crops. But it seems that with soils adapted as these soils are to raising truck crops, that these crops should be raised here to supply the summer hotels at Lake Wynola and other places throughout the section.

OVERFIELD TOWNSHIP

This township lies north of Falls and west of Lackawanna county. Like Falls township, its valleys are filled with Morainic materials pushed from the higher elevations which has lowered and rounded the hills and filled the valleys and has made the county more rolling.

Lake Wynola, in the southwestern part of the township, is located in a valley which was not filled as previously stated but at the same time the hills surrounding it have been levelled and smoothed down so that in every direction from the rounded hills surrounding it are magnificent expanses of moderately rolling agricultural soils, adapted the more gravelly and loamy types to raising potatoes, corn, wheat and oats and the clay types to raising hay and the pasture grasses. Going northward from this lake to Clinton township, the rolling country continues.

Looking northeastward from these hills, the west side of the Lackawanna Mountains and the rolling lands of the western township of that county stretch northeastward and southwestward dotted with farm buildings, a scene not equalled anywhere in these northeastern counties. Here are some of the most fertile and productive Catskill soils anywhere in the State and with the markets in the immediate mining districts ready to consume all and more than can be produced the best intensive farming that these soils can support should be practised. At Factoryville, in Clinton township, on the elevations above Tunkhannock Creek is one of the moderately rolling farming districts, the higher and more gravelly and loamy soils especially adapted to potatoes and grain raising and the lower and more clay types to hay raising.

NICHOLSON TOWNSHIP

Nicholson township lies north of Clinton and occupies the northeastern corner of this county. The rock strata outcropping in this township belong to the Catskill formation extending as high as the Cheny Ridge group of these rocks so well represented in Wayne county. Along Martin's Creek long lines of cliffs of these Catskill rocks rise many feet above the valley. Black boulders of limy rocks are found all along Martin's Creek valley both in this and Susquehanna county. Some of the uplands of the township are fairly fertile but most of these are stony and not easily farmed. Pasturing and apple raising are the agricultural operations best adapted for this section. Some dairying is done on the upland farms by means of which these soils are kept in good producing condition.

TUNKHANNOCK TOWNSHIP

Tunkhannock township lies west of Clinton and Overfield and has the Susquehanna River for its western boundary. North and south of Tunkhannock the county-seat, on the first terrace of the river upon the glacial deposit, is rolling land especially adapted to trucking because it is a fine sandy loam, warm and early, can easily be prepared for crops and will produce all market garden crops of the best

quality. A ready market is found at the summer resorts for which the lakes of this county are noted and which have to be supplied with these crops from other sources.

This glacial deposit, or rather deposits of glacial material, rises to a considerable height above the level of the river and eastward along Tunkhannock Creek until the Catskill rock strata come to the surface. These same soils occur northward of Tunkhannock to the outcropping of the rock strata of the Catskill. Some distance southeastward of Tunkhannock, Averys Mountain rises 2,000 feet above tide. It is a remanent of North Mountain coming in from the southwest and crossing the river. Eastward and southward from this mountain the land is hilly and stony until the vicinity of Osterhouts Creek is reached. Here the land is rolling and of good quality, derived largely from glacial deposits, apparently of local origin. Northward along Grayham's Creek this rolling country continues. Northeastward from Tunkhannock to Lake Cary the land is moderately rolling, quite stony but of good quality produces the regular farm crops—corn, oats, rye, potatoes, buckwheat and winter wheat. Along the Tunkhannock Pike are some splendid Catskill and glacial soil farms, especially in the vicinity of Mud Pond and about Lemon. Here are gravelly soils of both glacial and local origin, of superior fertility that do not wash and usually produce well in dry and wet seasons with a smaller amount of vegetable matter than soils of different formations do.

LEMON TOWNSHIP

This township lies north of Tunkhannock on the county line. Lake Cary, Mud Pond and Ox-bow Pond, already referred to, are located in this township. The rock strata of this township from which the soils are largely formed are the Lower Catskill and Catskill Chemung formations, some of which produce a stony and rough soil, but much of which is fertile containing limy formations upon which oak timber is growing. These rougher soils seem especially adapted for growing apples because trees growing here possess a vigor rarely seen anywhere.

WASHINGTON TOWNSHIP

Washington township begins with what is known as the Neck in the Susquehanna River and extends northward from here to Susquehanna county with Lemon township on the east and Meshoppen on the west. The Neck is a projection of land in the southern end of the township around which the river makes a circuit of about five miles, while it is only about two-thirds of a mile across the Neck at its narrowest point.

A terrace of some height above the river is formed of sand, similar to the terraces opposite La Grange along the river near Acton, Acton township this county. It was apparently formed in a similar manner and for this reason sandy soils occur here. These terraces occur well nigh along the river from here northward to Meshoppen. The rock strata from which the soils of this township are formed, in connection with the glacial deposits in the southern section, are the Lower Catskills and in the northern part of the Catskill Chemung formations.

Above the river hills northward from the neck the land is hilly, but does not wash badly and is fairly fertile which with good farm practice can be made to produce well. The Catskill Chemung soils in the northern part of the township are more hilly and stony at such places as Keiserville along the slopes above the streams and sometimes on the uplands but they are more fertile than the Catskill soils. Usually the rolling uplands are gravelly, easily farmed and produce large crops under good agricultural treatment. Oak timber grows on these soils whereas on the poorer Catskill, hemlock, beech, birch, some pine and maple prevail. From Keiserville northward the same Catskill Chemung rock together with glacial drift make the soil; some sections of which are nicely rolling and will produce splendid wheat crops, a crop that should be raised here.

MESHOPPEN TOWNSHIP

Meshoppen township lies west of Washington and its northern boundary is the southern boundary of Susquehanna county. The rock strata, together with the glacial drift from which the soils of the township are derived are the Lower Catskill instead of the Catskill Chemung as in western Washington township. Oak timber continues growing here, together with pine and hemlock, on some of the higher elevations. At Meshoppen the land is hilly, but some of the uplands between Vose and Meshoppen are moderately rolling and the soil is comparatively clean and easily farmed and produces the regular farm crops. From Meshoppen northward the county is rolling and the soil produces well. The northern townships of this county are natural apple lands and should be devoted to the growing of this fruit, while the more moderately rolling soils of some of the southern township should be devoted to raising dairy and market garden crops.

North of Jaynes Bend, above the river hills, are some splendid uplands gravelly and loamy soils formed from the underlying rocks and glacial drift especially adapted for raising the hay grasses. Some of these uplands were at one time ponds now filled up in which mucky soils occur adapted for the growing of all kinds of garden crops that

will thrive under these climatic conditions. These are also the best corn soils in all this section. Along the river in this township are a number of splendid farming sections well adapted for trucking and for hay raising.

BRAINTRIM TOWNSHIP

Braintrim township lies in the northwestern corner of the county between the Susquehanna River and Susquehanna county. The hills in many places rise abruptly from the Susquehanna River.

At Laceyville and from Keeneys Ferry to this town and east of it the country is rolling and adapted to all agricultural crops that will thrive in this climate. A short distance above Skinners Eddy along the Tuscarora Creek, near the Susquehanna River, a stratum of siliceous limestone occurs five feet thick which, in this section, should be more thoroughly examined and if possible used for agricultural purposes.

WINDHAM TOWNSHIP

This township lies south of Braintrim and part of Meshoppen township across the river. The rock strata outcropping belong to the Catskill and Chemung Catskill, but they do not take much part in the formation of the soils. The western part of this township is a low swampy region covered with glacial drift much of it too low for farming but will produce pasture grasses wherever the land is sufficiently elevated so that it can drain naturally. Splendid farming soils occur, easily farmed and will produce all crops that will thrive in these elevated parts. The levelling process effected by glacial action has converted Little Mehoopany Creek into a chain of lakelets east and west of Jenningsville and has also made a moderately rolling country which extends to the southern border of the township and eastward to the Susquehanna River. Northern Meshoopany township comes within the limits of this glacial deposit and is similar in soil structure. Northern North Branch and Forkston townships, the soils of which are formed of glacial drift and Catskill rock are similar in formation and adaptation to the soils previously described.

Southern North Branch, about all of Forkston and northwestern Monroe and western Eaton are covered by North Mountain, a rough and stony Pocono region little of which is farmed or even fit for farming. Dutch Mountain is a broad and almost level plateau with numerous swamps which was at one time farmed but at this time is well nigh entirely abandoned. Southeastern Monroe, Northmoreland and parts of Eaton townships, lying in the southeastern part of the county along the west side of the river have some of the best apple soils of this county. South of Bowman's Creek and west of Beaumont are moderately rolling soils, stony in many places but not too hilly for orcharding and well adapted for this purpose. At

Monroe township, is another such formation, and also at Mill City. Apple trees look thrifty, grow rapidly and bear well during rapid growth as was evident from the fruit on the young trees when this examination was made.

Potatoes yield very well in these stony and gravelly soils. So does oats, buckwheat and hay; but apples are the yielding and paying crop. At Centermoreland in Northmoreland township is another such section, even better than the sections previously discussed. Here apple growing has been established and is an industry of some dimensions. Wilkes-Barre is the market for these producers. Here is a large section of land both in Wyoming and Luzerne counties that should be planted with apples because of its especial adaptation for raising the fruit. From Centermoreland to Kellersburg the land is hilly but apples can be raised. At Kellersburg along the river is a section adapted to dairying for which it is used.

At South Eaton, in the curve of the river, is a splendid farming section. Bowman's Knob makes a rough and hilly section. Northward of this knob are a number of nicely rolling, trucking and dairy farms, with soils especially adapted for this kind of farming. This is one of the apple counties of the State where the Northern Spy, the king of apples, makes its largest yields, attains its highest color and most delicate flavor. The Baldwin and the Greening thrive equally as well here. A thirty-five acre orchard, only part of which has attained the age of full bearing, has yielded a net income of $3,500 for a number of years. There are thousands of acres in this county that will, with the expert attention this orchard is receiving, yield equally large returns.

LACKAWANNA COUNTY

Lackawanna county was established on the 21st day of August, 1878. It contains 288,640 acres, of which 134,160 acres is land in farms, and of which 58,760 acres is improved farm land. 1,250 acres were planted in corn in 1909, yielding 39,014 bushels; 4,651 acres were sown with oats, yielding 101,440 bushels; 19 acres were sown with wheat, yielding 315 bushels; 2,152 acres were sown with buckwheat, yielding 37,077 bushels; 1,037 acres were sown with rye, yielding 14,309 bushels; 2,763 acres were planted with potatoes, yielding 263,917 bushels; 26,488 acres, were sown with all forage crops, yielding 35,845 tons of the various kinds of hay. Of the 58,760 acres of improved farm land, 38,360 acres were used in raising farm crops,

while 20,400 were not so used and were likely producing weeds. At this time Lackawanna county had a population of 259,570 to feed, 13,399 cattle, 3,675 horses, 87 mules, 4,218 swine and 2,373 sheep.

Lackawanna county contains only five of the geological formations from the outcropping strata of which its soils are derived, namely, the Catskill red shale and sandstone, the Pocono sand, the Mauch Chunk red shale the Pottsville conglomerate and the coal measures. The county is mountainous and hilly, but is one of the richest agricultural counties in the northeastern section of the State.

Bucks township occupies the eastern extremity of the county and joins Monroe on the southeast. Its soils are formed well nigh entirely except where the township joins Monroe, from Pocono sand but sufficient of the Catskill comes into it with the Pocono, at such places as Gouldsboro to make soils adapted to agriculture, but especially for fruit and potato raising. In many places the soil is stony, especially on the hillsides, and in many of the valleys, while the upper levels are not so stony and have richer soils better adapted to farming.

COVINGTON TOWNSHIP

Covington township, directly northeast of Bucks, has the same geological formation and soils formed from the same materials. North of Clifton and in the vicinity of Daleville and Hollister are stretches of good farming land where the red Catskill and Pocono mingle in the formation of the soil.

SPRING BROOK TOWNSHIP

Spring Brook township, north of Bucks and north and west of Covington, has some good agricultural soils at such places as Welsh Settlement where some good farming is done and where, on the Catskill red shales fairly fertile soils exist.

MADISON TOWNSHIP

This township, north of Covington and west of Spring Brook, contains quite an acreage of farming land at such places as the vicinity of Moscow on the D. L. & W. R. R. and at Madisonville P. O. and south along the D. L. & W. R. R.

ROARING BROOK TOWNSHIP

Roaring Brook township, partly west of Madison and Jefferson, contains some farms, but they are hilly and rough products of the Bald Mountain which forms the division between these eastern townships and the coal fields

JEFFERSON TOWNSHIP

Jefferson township lies north of Madison. Its soils are formed of a mixture of Catskill and Pocono strata of good productive capacity, but not usually well farmed.

This eastern section of Lackawanna county, as a whole, is hilly, rocky and stony but contains some of the best agricultural soils found anywhere in the State, in the Catskill and the Pocono sandstone mixture. The higher elevations or tablelands usually have the strongest soils, while many of the hillsides and the valleys are stony and rocky and difficult to farm, in fact, large areas can not be farmed and should either be refortested or where feasible, put into permanent pasture and apples. Many of these soils are not entirely formed from the disintegration of the local rock, but the glacier, which has ground up the local rock, has added some mineral constituents, and wherever this has happened the soils show the effects, especially where the glacial material is deep. Apple trees grow luxuriantly here and bear well and do not seem affected with the fungus diseases, such as collar rot and many other diseases such as other sections of the State are obliged to contend with. About all the farmers raise apples but do not spray for insects or fungus disease and do not cultivate, mulch or fertilize their trees.

In a large number of orchards examined, the fruit is well colored and there are few orchards that have been permanently injured by neglect. The more stony hills and upper hillsides, not stony enough to be reforested, should be planted with apples and the clean land used for pasture or agricultural crops and the land that is too stony and rough for doing these things should be reforested or planted with sugar maples, and these made a source of revenue to the farmer. Corn, oats, hay, buckwheat, some rye, potatoes and a few market garden crops are raised here. The crops that nature indicates will thrive best here, are apples, timothy, orchard grass, and in the low places red top. This eastern section is drained by Spring Brook, Roaring River and other smaller streams. The D. L. & W. R. R. and W. & E. R. R. lines run through this part of the county.

The townships in the coal belt, between the Moosic and the Lackawanna mountains, have some naturally fertile soils along the Lackawanna River, formed by the disintegration of local rocks and those brought from considerable distances, as well as from the local mountains by both the river and the glacier and deposited in this valley. Lackawanna township in the southern section of the coal formation, is nearly all hilly, rough and stony, especially at such places as Moosic and Lackawanna, and little farming is done. Scranton, Dickson, Carbondale and Fall townships have coal shale soils, some of which are fertile and could be and should be farmed at such places as

Oliphant, Taylorsville and many other places, where the soil is comparatively free of stones and derived from limy coal shales and glacial material and, therefore, fertile, and both because of its location and formation, should be devoted to market gardening. Between Archbald and Jermyn the land is rolling, some of it stony and rough, but a considerable acreage adapted for farming, and with all the demand for farm and horticultural crops here, should be farmed not only for this reason, but also because it has been burned over so often that trees grow only here and there, and there is no longer a continuous forest and will not be for years to come. A few more burnings will destroy tree life completely, and still a few more will obliterate fern life, and in a few years not enough roots will remain in the soil to hold it in place, and its permanent destruction will have begun, without any possibility of stopping it.

At Mayfield a few farms on the hillside show what can be done in the way of raising the ordinary farm crops, such as oats, corn, rye, grass, potatoes. At Carbondale and vicinity there is considerable farming and more could be done. The townships along the Lackawanna Mountains are all in the Catskill formation except along the mountain where the Pocono sand, the Mauch Chunk red shale, the Pottsville conglomerate, as well as the glacial drift take part in the formation of the soils. The glacial drift plays an important part in these soils by adding mineral formation, containing substances not contained in the native rock strata, but very essential in making soils productive.

RANSOM TOWNSHIP

Ransom township lies northwest of the Lackawanna Mountain and east of the Susquehanna River, and comes to a point where the river cuts through the mountain. The rock strata, together with the glacial drift, from which the soils of this township are formed, range from the Catskill up into the anthracite coal measures east of the Lackawanna Mountain, upon the crest of which, the Pottsville conglomerate prevails and from which it dips eastward under the coal measure rock, and, as already indicated, reappears east of Moosic Mountain and there forms a large area of the soils of these eastern townships.

The coal measure strata rest on top of the conglomerate, and, as already stated, together with the glacial drift, form the soils of the section of the county, between the Lackawanna and Moosic mountains. Going northwest of the Lackawanna Mountains all the rock strata down to the Catskill have disappeared and these form the basis of the soils in the section of Ransom township northwest of the mountain. These soils are rough and hilly along the northwest

side of the mountain, but as the rock strata become more flattened, the country becomes more moderately rolling and forms soils well adapted to farming along the lower hills, which here are only approximately from 500 to 600 feet above tide, while the top of the Lackawanna Mountain ranges from 1,200 to 1,300 feet above. Between Joslyn Pond and Milwaukee is one of the moderately rolling sections of farming land where considerable dairying is being done for which the soils are well adapted.

NEWTON TOWNSHIP

Newton township lies west and northwest of Ransom. This is one of the best farming townships in this county, because it contains among the most fertile soils derived from glacial drift from softer local formations and from the disintegration of the Lower Catskill strata. These soils, taking them as a whole are not as stony as many of the Catskill soils are, further north. Disintegration has proceeded farther and consequently a soil has been made, better adapted to agricultural crops than the more stony and rocky soils and one that is more easily farmed.

Here is where the agricultural crops of this county should be raised, and in fact, where they are being raised because these soils will produce larger yields with less work and expense than elsewhere in the same formation. Ninety and Hundred day Dent Corn finds a congenial climate here. As highly as seventy bushels of shelled corn per acre have been raised in this and surrounding townships. Newton Center and vicinity is one of the sections of this township where good farming is being done.

ABINGTON TOWNSHIP

Abington township lies northeast of Newton and west of Wyoming county. A range of hills passing through Clark's Summit runs through the southern part of the township. The soils of this part of the township are formed from glacial drift, and the disintegration of the strata of grey shales of the Catskill formation. Few of the red shale and apparently more fertile soils occur along this range of hills. Further north, at Dalton, some of the more reddish formations come in and the land is more moderately rolling not as stony, as along the hills further south. From Dalton eastward and north eastward the land continues rolling and fertile. Potatoes and hay are among the best money crops in this section. From 200 to 300 bushels per acre of marketable potatoes have been and esaily can be raised in this section for which there is a ready and profitable market in the city of Scranton where the crops are usually marketed by the farmers selling directly to the consumers.

Timothy hay is another of the profitable crops for which these soils are usually adapted. Timothy grows along the highways. Several farmers visited in this section, who make hay one of their chief money crops, have been able by the application of 1,000 to 2,000 pounds of lime per acre, to raise two tons of hay per acre, for a number of years in succession. One of these farmers sold $1,500 to $1,800 worth of hay off a 150 acre farm and beside raised sufficient roughage and a large part of the grain to feed twenty-two head of milk cows making from 6,000 to 8,000 pounds of milk annually. The soil on this farm is not any more fertile than that of the surrounding farms, but it is farmed well. There are several limy formations in the strata of the Catskill rocks throughout this section and whenever these strata form the basis of the soils, oak timber appears. These strata usually form a reddish soil.

BENTON TOWNSHIP

This township lies north of Abington and joins Susquehanna county in the north. This township is covered with glacial debris to such an extent that eight lakes have been formed within it through the damming of the valleys by the glacier, grading down the hills and pushing these broken rocky formation into the valleys, as well as by leaving the surface strewn with materials brought from more distant places so that the underlying rocks here do not enter into the formation of the soils to the same degree as elsewhere in the county, but evidence of their influence is manifest. This is a hay township as well as an apple township. The Welsh orchards have been producing apples in this township for more than fifty years with only the soil mulch system and by the use of manure, the trees in these older orchards look as thrifty and bear as well as do those of more recent planting. These orchards are located on the higher elevations on well drained soils, where the underlying rock strata enter very largely into the formation of the soils.

SCOTT TOWNSHIP

Scott township lies east of Abington and Benton and south of Greenfield. Both of these townships touch the foot of Lackawanna Mountain, and their eastern border is formed of Pocono sandstone, which, even though modified by glacial action, forms a rougher and more hilly and stony section not well adapted to any agricultural operations, but will produce apples. The trees here do not grow large but are thrifty and will produce well. Cutting back and keeping down the tops, is not necessary here. The western section of these townships are similar in formation to Abington and Benton, their soils being composed of glacial drift and the Catskill red shales

and sandstone strata lying between the Honesdale sandstone and the Mount Pleasant red shale which outcrop on the higher elevations.

FELL TOWNSHIP

Fell township occupies the northeastern corner of the county, joining Susquehanna county on the north and Wayne on the east. This township is hilly, especially the central part, through which the Lackawanna Mountain passes. The western section, lying west of this mountain, is covered with glacial debris and its soils are formed from this and the underlying rock strata above the Cherry Ridge limestone which outcrops near Crystal Lake of sufficient thickness to warrant a thorough investigation as to whether lime could be made out of it or whether it could be crushed sufficiently fine to be applied on these soils as crushed limestone. The sections of this township, the soils of which are fitted for raising agricultural crops, should be used for raising these crops because of the large demand for all agricultural products in this section. These crops should largely be converted into the finished animal products, such as milk and beef and pork and poultry.

The soils of the western section of this township, as well as a considerable acreage of the eastern section east of the Moosic Mountain are natural grass soils, and will grow a sod upon which to apply the manure of the dairy or beef herd. A heavy sod well manured a year, or even two, before plowing down is the best source of vegetable matter for maintaining moisture and furnishing fertility for a corn crop that can be had in this section of the State.

Timothy grows native here. A rotation in which timothy, hay and dairy products furnish the money returns seems well adapted for this and surrounding counties.

WAYNE COUNTY

Wayne county was organized by the Act of March 21, 1798. It contains 472,960 acres, of which 375,557 acres is land in farms, and of which 123,486 acres is improved farm land. 3,031 acres were planted with potatoes, yielding 97,640 bushels; 5,828 acres were sown with oats, yielding 149,675 bushels; 14 acres were sown with wheat, yielding 286 bushels; 4,834 acres were sown with buckwheat, yielding 94,613 bushels; 1,054 acres were sown with rye, yielding 14,052 bushels; 2,882 acres were planted with potatoes, yielding 286,268 bushels; 65,890 acres were sown with all forage crops, yielding 75,915 tons of the various kinds of hay. Of the 123,486 acres

of improved farm land, 83,533 were used for raising farm crops, while 39,953 were not so used and were likely producing weeds. At this time Wayne county had a population of 28,236 to feed, 37,147 cattle, 7,041 horses, 84 mules, 8,291 swine and 8,612 sheep.

This county occupies the northeastern corner of Pennsylvania, with the New York State line for its northern and the Delaware River for its eastern boundary as far south as Narrowsburg from whence the Pike county line makes its eastern boundary, and the Monroe county line its southern. The soils of this county, like those of Susquehanna, are derived from the underlying Catskill rock and the glacial drift. The drainage of the county is accomplished by the numerous small streams flowing from the large number of lakes into the Delaware River (except in the northern part referred to later) which makes the eastern boundary of the county for more than half of its eastern border.

SCOTT TOWNSHIP

This township occupies the northern extremity of the county, with the New York State line forming its northern boundary, and the Delaware its eastern. The soils of the township are derived from glacial drift, and along some of the slopes of the hills where the Catskill rock outcrop, it combines with the drift material in the formation of the soils, with wherever the red sandstone outcrops decided beneficial effects. A high divide enters this township in the northwestern corner, and extends southwestwardly through the entire township into Preston, from which the water on the eastern slope flows into the Delaware, and that from the western into the Susquehanna River. Along this divide are a number of small lakes, usually surrounded with a more moderately rolling section of land with soils derived from the glacial drift which if the soils are sandy and gravelly, are usually deep with fairly large water, but poor fertility holding capacity, adapted for raising the pasture grasses, oats, rye, buckwheat, potatoes and some the legumes, among the short season, the Canada field pea, the winter vetch and northern grown crimson clover.

Along the hills where the Catskill shale and sandstone takes part in the formation of the soils, they are usually rocky, and stony, but where disintegration has proceeded sufficiently far to make sandy and loamy soils, the land is usually more fertile and will produce larger crops than the gravelly or sandy glacial soils will, but not as large as the loamy types of the glacial drift soils, considerable areas of which usually occur on the moderately rolling land above the lakes. These are the most fertily soils in this township, and with some carbonate of lime will produce all the agricultural plants that will thrive under prevailing climatic con-

ditions As previously indicated, the outcropping Catskill sandstones and shales enter the formation of the soils with both evil and good effects. The evil effects are visible along the cliffs, near the northern border of the township made by the so called Honesdale sandstone which has resisted the agencies of disintegration most effectively. The same thing occurs along the southern and western borders of the township.

PRESTON TOWNSHIP

This township lies south of Scott on the Susquehanna county line. The soils of the township are derived from the glacial drift and the Catskill, wherever this outcrops sufficiently to take part in the formation of the soil. In this township Moosic Mountain terminates in two knobs—Sugar Loaf and Ararat, the former 500 and the latter 700 feet above the surrounding country, capped with massive rock. The surface throughout this section is very broken, and large bowlders lie scattered about the country, making farming operations difficult, and not remunerative. Apple trees grow naturally throughout this section, even in the roughest kind of land, showing that if agricultural crops cannot be raised here, apples can be.

Another prominent feature which effects the agriculture of this township is the large number of lakes and ponds occurring within its limits. Not less than twenty of these, varying in size from little ponds of two acres up to lakes of fifty and seventy-five acres occur in this township. Some of these lakes are surrounded by marshes and swamps, with soils of little value, while in some cases the marshes and swamps extend from one lake to another, as is the case between Eastern Spruce and Lake Como, in others the soil between these lakes derived from glacial drift is deep and fairly fertile, and will produce the pasture grasses splendidly, as well as, such agricultural crops as oats, Canada field pea, rye, buckwheat and potatoes. A number of these swamps, which are covered by a considerable thickness of accumulated vegetable material, have become sufficiently dry and warm to be cultivated and they make the most productive soils for the raising of such crops as celery and onions of which they will produce large yields of superior quality, while those containing a less amount of vegetable matter can be used for raising truck crops if they can be handled in such a way as to produce large yield of splendid quality. The soils of the higher elevations of this township are derived from the underlying Catskill sandstone, and are adapted for raising the regular farm crops that thrive throughout this section. West of Preston, the limy or calcareous bowlders lie scattered about the hills, and wherever these have sufficiently disintegrated, the soils show by the increased production and their physical condition what the effects would be if these limy stones

were ground and applied to the land. About two or three miles west of Lake Como this same limestone crops out in such a way that it could be quarried, ground and applied to the land.

BUCKINGHAM TOWNSHIP

This township lies east of Scott and Preston, along the Delaware River. The soils are derived largely from the Catskill. The soils are derived from the same rock as those previously discussed.

MANCHESTER TOWNSHIP

This township lies east of Buckingham, also along the Delaware River. The soils are derived largely from the Catskill. The land is hilly, especially along the Delaware River where these Catskill rock frequently rise above the river in cliffs, and produce magnificent scenery, while away from the river where the softer strata occur and where disintegration, in limited areas, has made deeper soils, the land is fairly fertile and will produce the regular farm crops such as corn, wheat, oats, rye and the clovers especially when lime is applied.

DAMASCUS TOWNSHIP

Damascus township lies south of Manchester, with the Delaware River for its eastern boundary. Along the Delaware River the land is equally as hilly as that of Manchester, with as grand and even grander scenery, for instance at such places as Narrowsburg, New York. In the northwestern corner of the township at Duck Harbor Pond is one of the sections of land similar to some discussed in Preston township. The hilly and rolling land of the western and southern parts of this township have soils largely derived from the Catskill red shale and, therefore, are more fertile than is usual with the soils of the township previously discussed, all of which will be referred to later.

LEBANON TOWNSHIP

This township lies south of Manchester, and Buckingham and west of Damascus. This is one of the roughest townships of this county, with the farming soils confined to the uplands, because along about all of the streams the rock covers the surface, making farming impossible. The northern part forms a divide from which the water drains northward and southward, while in the northeastern corner is Big Hickory Knob which rises 400 to 500 feet above the surrounding country, and is surrounded with a rough country in which there is little farming land, but with all the roughness, forest trees especially the beech, the birch and the maples grow rather luxuriantly, and in many places the ground is covered with so dense a forest

and undergrowth that it seems there is no longer a struggle for fertility but sunlight. Little Hickory Knob rises from 250 to 300 feet above the surrounding country, and lies three miles northwest of Big Hickory surrounded with a similar country. The calcareous conglomerate or the limy conglomerate also appears in this vicinity and should be thoroughly investigated whether it is fitted when ground finely for liming this land.

MOUNT PLEASANT TOWNSHIP

This township lies west of Lebanon on the Susquehanna county line. The soils of this township are derived from the Catskill shales and sandstones. At Belmond Lake, in the northwestern part of this township, is quite an extensive marsh, with marshy land, while in the vicinity of a number of the smaller lakes, similar but more limited areas of these marshes occur, which, where the land has become sufficiently dry, as is the case with the smaller lakes, the soils are among the most productive in the county. Along the western border of the township the remnants of the Moosic Mountain rise in several peaks above 2,000 feet, making a rough and hilly country of little value for farming land. The red shale of the Catskill formation occurs along the eastern border of this mountain at Mt. Pleasant, and makes a more fertile soil, though hilly, than the grayer shales do, adapted for corn, rye, oats and potatoes. The clovers will also thrive in these soils, especially when lime is applied. About two miles south of Mt. Pleasant Village, the Chemung ridge limestone, to be more fully discussed later, outcrops in the hills in such position that it could be quarried and crushed for liming. In the southeastern part of the township the red shale again makes the basis of the soil, with similar capacities. In the northeastern part of the township, the limy rock lie scattered about the hills.

CLINTON TOWNSHIP

This township lies south of Mt. Pleasant, with both the Susquehanna and the Lackawanna county lines for its western boundary. In the eastern part of the township the hills are rounded with less steeply sloping sides, while from the central part westward the land becomes more steeply hilly until in the western part, especially the southwestern, the land is rough and mountainous, and not adapted for farming. In the eastern part of the township the land is similar with similar capacities and adaptations, as in the township previously discussed.

DYEBERRY TOWNSHIP

This township lies east of Clinton and south of Lebanon. Throughout the southern part of this township the red shales of the Catskill

strata mix with the glacial material in the formation of the soil and make it more fertile, adapted for raising the regular farm crops that thrive under prevailing climatic conditions.

OREGON TOWNSHIP

This township lies east of Dyeberry, south of Lebanon and west of Damascus. The red Catskill soils largely prevail here. A ridge passes partly through the central part of the township upon which the gray shales are the predominant rock. The same is true of the western part of the township. These soils all have similar capacities and adaptations as those previously discussed.

BERLIN TOWNSHIP

Berlin township lies south of Oregon and Damascus. The soils are largely derived from the Catskill red sandstone, but disintegration and glacial action does not seem to have been as effective as usual, because many of these strata make cliffs throughout this township. Some splendid apple soils occur in this township which should be developed for the raising of this fruit in connection with such soil improving crops as will maintain the fertility of the land, and make such a wood growth as will be sufficiently ripe and strong to resist the rigor of climatic conditions and produce fruit.

TEXAS TOWNSHIP

This township lies south of Derry and east of Berlin. Honesdale, the county-seat of the county, is located in the eastern part of this township at the juncture of the Dyeberry and Lackawaxen creeks. The soils of the township are derived largely from the red shale and sandstone of the Catskill formation, except in the western part where the gray strata make the basis of the soils. The land above the streams throughout this township is rolling and productive with fairly deep soils, with fair water and fertility holding capacity adapted for the highest developed farm practice possible in this county. Wheat could be made a paying crop here, because these soils will produce fairly large crops of a hard red, high milling quality. A rotation of corn, into which timothy, red, Mammoth or alsike clover, or cow horn turnips, or one of beets together with crimson clover, winter vetch and rye had been sown some time in July or August, these plowed down the following spring and the land sown with Canada field peas and oats and with this crop, the land seeded with the clovers and timothy, to which alfalfa might be added, should work out all right.

The valleys of the streams contain deposits of drift materials for considerable depth and, therefore, the soils in these valleys are derived from this material which comes largely from the hills that

have been scoured down by the glacier. Besides these formations, steep slopes with thin soils or cliffs with no soils occur along the streams, as they do in all the townships previously discussed, which where sufficient soil has been formed should be maintained in forest. At Honesdale, along the Lackawaxen, is a cliff, and further south a steep slope, illustrating both conditions above referred to. South or probably southwest of Honesdale, the Cherry Ridge limestone crops out in a band four feet thick and if sufficiently pure could be ground and applied on the soils of this section with splendid effect.

CANAAN TOWNSHIP

This township lies west of Texas and Dyeberry townships on the Lackawanna county line.

SOUTH CANAAN TOWNSHIP

South Canaan township lies south of Canaan, also on the Lackawanna county line. These two townships have soils derived from the same strata, the Catskill, Pocono and the conglomerate. In the eastern parts of these townships the underlying Catskill gray shale and sandstone, together with the drift material makes rocky, stony, and in some places, loamy soils, and again loams mixed with these formations adapted fairly well for raising the agricultural crops. The soils about the lakes are similar to those previously discussed and need no further reference here. The western parts of these townships are hilly and even mountains, with rough, rocky and stony land not adapted for farming, but for raising timber and in some few instances, apples.

CHERRY RIDGE TOWNSHIP

This township lies east of South Canaan and south and west of Texas. The soils of the eastern and central parts of this township are derived from the Catskill red shale and sandstone, while those of the western part are derived from the gray strata and the glacial materials. The Cherry Ridge limestone, referred to in the discussions of the previous townships of this and Susquehanna county, was named for Cherry Ridge Postoffice, or the village of Cherry Ridge, which is located in the eastern central part of this township. The limestone outcrops just west of Cherry Ridge Postoffice. This limestone has been burned to lime and used for agricultural purposes with gratifying results. The following two analyses represent the first the composition of the richest and the second that of the poorer specimens of the outcrop.

(Penna. 2nd Geo. Survey G[5] Page 197)

	I	II
Carbonate of lime,	64.392	19.785
Carbonate of magnesia,	1.816	3.518
Oxide of alumina and iron,	4.145	8.903
Phosphorus,	0.050	0.095
Silicious matter,	28.800	65.470

The first of these analyses represent a limestone which can be burned into lime, while the second cannot; but if it were sufficiently shaly it could be finely ground and with an application of about three times the quantity of the purer stone, it should produce as good results. But little of this stone is soft and shaly, and easily crushed, and therefore, it would probably prove too expensive, and recourse must be had to the purer stone if a sufficient quantity of it exists in this and the other localities in which it has been indicated to exist throughout this and Susquehanna counties.

This limestone also occurs at Cadjou Lake, in the northeastern part of this township, as well as in other sections. It seems that the farmers of the various communities in which this stone outcrops should make a thorough investigation of the quantity available, and the expenses of quarrying, or mining, crushing, grinding and transporting it throughout the various districts, so as to determine whether it would pay the farmers to go together, and put up a cooperative crushing and grinding plant wherever the stone occurs in sufficient quantity to justify such an undertaking. The soils derived from the Catskill red shale sandstone and glacial materials are naturally chemically inactive, while those derived from the gray shales sandstone and glacial material are well nigh chemically dead even organic matter, partly because of climatic conditions, decomposes rather slowly in both these soils, and therefore to stimulate chemical action in the red soils and to revive the gray, and fire the agencies of decomposition, a soil condiment is necessary which in this case, from the results that have been obtained, seems to be lime, either as the carbonate or as the caustic lime. Lime produces better results in the red soils than in those derived from the gray shales, probably because of the greater chemical activity of the composition of the former. The following analysis gives the composition of the red shale.

(Pa. 2nd Geo. Survey G[5] Page 29)

Silica,	59.260	
Alumina,	19.877	(by deduction)
Sesqui oxide of iron,	10.071	
Lime,	0.250	
Magnesia,	1.917	

Sulphuric acid, ...	0.012
Phosphoric acid, ...	0.158
Water, ...	3.600
Alkalies, ...	4.855

This analysis indicates that after the disintegration of this rock, the soils derived from it would likely be deficient in lime, but whether the beneficial results derived from lime are entirely due to supply this deficiency or to stimulating the agencies of decomposition, or whether the lime has the effect of liberating some of the alkali, of which this rock contains a large amount, and make it available for the use of the plants, depends upon whether the alkali is largely potash and if it is potash, lime in these soils becomes a fertilizer, a stimulator of organic decomposition, and a liberator of potash. Wherever lime performs such functions, its use should be encouraged.

PALMYRA TOWNSHIP

This township lies south of Berlin and east of Cherry Ridge, on the Pike county line. The soils are largely derived from the gray shales and the glacial material with similar capacities and adaptations as those previously discussed.

PAUPACK TOWNSHIP

This township lies south of Cherry Ridge and Palmyra. The soils of the township are derived from the gray shales in the eastern and western parts and from the red Catskill through the central part of the township, while along Paupack Creek, which flows on a glacial filled valley at so gentle a rate that its movement is scarcely perceptible, the land is gently rolling with deep, in some places, wet, soils derived from glacial material, needing underdrainage but which wherever underdrained makes the best farming land in the township.

SALEM TOWNSHIP

This township lies east of Paupack and south of South Canaan, on the Lackawanna county line. The soils are largely derived from the gray strata of the Catskill rock. In the western part of the township the land is rough, rocky, stony and even mountainous, not adapted to farming. Some mucky and swampy land occurs in the northeastern part of the township with adaptations such as have been before discussed. Sterling township, which occupies the southwestern corner of the county, has soils derived from the same formations, with similar capacities and adaptations as those of Salem, except that the Cherry Ridge limestone outcrops at such places as South Sterling and its vicinity and also short distances from Noblesville, which makes it possible to get lime for these soils in this township.

In the discussions of the various townships, reference has been made to the adaptation of the soils of this county for apple raising, especially the Northern Spy and the Baldwin. The same soil and probably climatic adaptations exists in Susquehanna, Wyoming, Luzerne, Bradford, Tioga and smaller or larger sections of others of these northern counties for raising these and other varieties of apples, and in order that advantage might be taken of these soil and climatic adaptations and that the growing of this fruit might be made a profitable and in so far as possible a permanent industry such soil conditions should be established and maintained as evidently exist in the soil in the natural uncultivated state, in which apple trees grow like forest trees, and bear large crops of fruit. Just how such soil conditions can be created the author does not pretend to know, but that it can be done he believes. In order that the fruit industry might be put on a more permanent basis in this section, and that all available fruit might be profitably used, fruit raisers co-operative canneries should be built in accessible places and fallen and over ripe fruit canned, and in order that the canning industry might be made more profitable, and that a longer canning season might be provided, such crops as peas for the growing of which some of the soils throughout this and the other northern counties are especially adapted should be grown for this purpose and the vines siloed and fed to animals, and the manure applied to the soils. Sweet corn can also be profitably grown in these soils, and canned. With such soil adaptations, it is possible to work out a succession of crops by means of which the fertility of the land can be maintained and the agricultural and the fruit industries be put on a permanent basis.

SUSQUEHANNA COUNTY

Susquehanna county was set off from Luzerne by an Act of Legislature, passed February 21, 1810, but was not fully organized until 1812. It contains 527,360 acres, of which 472,428 acres is land in farms, and of which 296,057 acres is improved farm land. 5,735 acres were planted with corn in 1909, yielding 172,186 bushels; 14,994 acres were sown with oats yielding 323,097 bushels; 210 acres were sown with wheat, yielding 3,537 bushels; 7,695 acres were sown with buckwheat, yielding 148,165 bushels; 730 acres were sown with rye, yielding 8,927 bushels; 4,210 acres were planted with potatoes, yielding 463,485 bushels; 108,024 acres were sown with all forage crops, yielding 138,994 tons of the various kinds of hay. Of the 296,-

057 acres of improved farm land, 141,598 were used for raising farm crops, while 154,459 acres were not so used and were likely producing weeds. At this time Susquehanna county had a population of 37,746 to feed, 55,497 cattle, 9,732 horses, 93 mules, 13,185 swine and 16,860 sheep.

Nearly the whole surface of this county consists of rolling hills of Catskill red and grey shales, sandstone, conglomerate, with calcareous formations and some Chemung, although largely covered with drift in the valleys in the northern section, and a little Mauch Chunk red shale in the southeastern corner where a little anthracite coal occurs. In the southeast corner, in Clifford township, the anthracite coal, the conglomerate and the Mauch Chunk red rest on a mountain of Pocono sand where the Lackawanna and the Moosic mountains come to a point. West of these mountains the whole formation is the Catskill red and grey shales. The east branch of the Tunkhannock Creek drains this township, and along the valleys and the valleys of its tributaries are good farming soils as well as on the plains of the hills, with the exception of Elk Mountain, North and South Knobs, which are Pocono and are rough and stony and not suited for farming. In this township the mountain limestone, locally called "nigger head," by the second geological survey, is found in large bowlders and wherever these disintegrate the soils are more productive showing the need of lime.

HERRICK AND ARARAT TOWNSHIP

Herrick and Ararat townships, directly north of Clifford, all on the Wayne county line, have the same geological formation, the Catskill series of rock. This township lies directly north of Clifford and most of its territory has an elevation of 2,100 feet above tide; while North and South knobs, in what are known as the Elk Mountains, rise, the former to 2,700 feet above tide and the latter, 2,575 feet, capped with grey sandstone. The Cherry Ridge limestone is found in this township, especially the western part where large black bowlders lie about the fields. This stone is sufficiently plentiful to burn it into lime or to grind and apply as ground limestone to the soil. This stone can be sold for a dollar a ton at the crusher and sufficient made to justify the operation.

These townships are within the natural apple section, and where the hard pan, which prevails here as in other sections of the county, does not come too close to the surface, apple trees are as thrifty as in Wayne county. Grass is a natural product, as in well nigh the whole county, and should be maintained as one of the money crops of the farm as it has been in the past. All over the township, at eleva-

tions of 2,000 feet, are abundant evidences of glaciation and the great thickness of, Moraine material and the numerous bowlders, especially is this so along Low Lake near the center of this area.

ARARAT TOWNSHIP

Ararat township is very similar to Herrick, except that it is the upland or herding ground of several streams and, therefore, has rolling upland elevated about 2,000 feet above tide. The township is strewn with Cherry Ridge black limestone all brought about by glacial action. At the northern line of the township, near the railroad, the Cherry Ridge limestone is ten feet thick with limy formations above it. The descent from Ararat summit to the Tunkhannock Creek is fairly steep and shows the effects of erosion.

NEW MILFORD

This township is drained by Salt Lick Creek and its tributaries. Its land is rolling and nowhere very hilly except along the valleys of the larger streams, as at Summerville. At New Milford the soils are formed of alluvium, with the exception of glacial remains immediately north of the town. With numerous lakes and lake bottoms and the rolling hills with tablelands of considerable extent, and fruit trees growing naturally, and land especially adapted for grass and oats and peas, there are special openings for advanced farming here.

JACKSON TOWNSHIP

Jackson township lies east of Milford. Its rock belong entirely to the Catskill, and because of the cliffs formed along the hillsides exposing the Honesdale sandstone, belonging to the Catskill series, it is evident that these rock together with the glacial drift and its action have taken part in the formation of the soil.

THOMPSON TOWNSHIP

Thompson township on the Wayne county line is one of the small townships of this county. The rock belongs to the Middle Catskill formation. Considerable of the land is rough with great cliffs of sandstone exposed along the hills, while the lower lands are strewn with large bowlders, making farming difficult. There are some exceptions, but not many.

Montrose, the county-seat, is located in Bridgwater township, on the highest land in this section of the county. The soils in this township are formed from the glacial drift, the red and grey Catskill. The red usually predominates on the lower hills and the grey in the valleys and on the higher hills. A good illustration of this can be seen near Summerville, in New Milford township, where along

a hillside about the village the red lies on top of the grey, and again the grey on the red. The red is better adapted for the grains, such as corn, oats and wheat; while the grey seems to be better adapted for hay and fruit, especially apples. Apple trees seem to grow more luxuriantly on the grey than the red.

FRANKLIN TOWNSHIP

This township, directly north of Bridgwater, is geologically similar, but is more hilly in the northern section. Snake Creek largely drains this township. It has only one lake, and that not entirely within its limits, but it has plains evidently sometime under water, at such places as west of Upsonville, where a beautiful valley opens with soils adapted to all agricultural crops that will grow in this climate, as is evident from the crops that are being raised.

At Franklin Forks, in this township, Snake and Silver creeks come together and flow north through Liberty township into New York State and into the Susquehanna. The red shale, referred to as occurring in Bridgewater township, occurs here, but not as extensively.

LENOX, LATHROP, GIBSON, HARFORD AND BROOKLYN TOWNSHIPS

Lenox and Lathrop townships border on the Lackawanna and Wyoming county line. The rocks of these two townships belong entirely to the Catskill formation. The valleys of Lenox are filled to great depth with Moraine materials, while the hills and the hillsides soil contain considerable coarse sand materials derived from the Montrose sandstone group. As already stated, the rock of Lathrop township belong to the Catskill; but here the calcareous or limy strata appear and take part in the formation of the soil. Along Marlin Creek in the vicinity of Foster and may other places, these limy formations appear and their effects are readily seen in the forest and crops.

About a half mile south of Foster, one of these limy formations outcrops in the railroad cut. Still further north, descending from the summit of the hill, is a perpendicular cliff of the limy formation, which seems quite persistent and of which large bowlders are scattered over the soils and wherever these have disintegrated, crops grow more luxuriantly. Wherever these bowlders lie blue grass and clovers grow.

GIBSON TOWNSHIP

Gibson township lies north of Clifford, and like all townships of this section, the Catskill formation forms the basis of its upland soils. The strata of the Cherry Ridge lime occurs in the eastern section of the township from 6 to 8 feet thick, along the road from

Herrick to Gibson, but are not as pronounced as at Foster, and likely not as pure; at least the effects are not as evident. Some of the upland soils of this township are moderately rolling, and easily farmed and produce well.

HARFORD TOWNSHIP

Harford township lies west of Gibson and north of Lenox. This is one of the oldest settlements in the county, especially the village of Harford whch was settled by Connecticut people. The valley or lake depression, in which this town is located, is one of the fertile sections of this township, well adapted to dairying and the raising of all farm crops that will thrive in this climate. Tyler Lake is nearly in the center of this township and it, together with the smaller lakes northeast and west of it, are surrounded by beautiful rolling land, some of it wet and likely needs under-draining, but with good agricultural practice can be made to produce large crops of timothy hay, oats and the clovers. The southern section of the township is more hilly, but not to such an extent as to make farming difficult. The black limestone already referred to, crops out in the railroad cut near Oakly but seems very impure though it might be sufficiently pure to be crushed and used for lime in farming.

BROOKLYN TOWNSHIP

Brooklyn township lies west of Harford and south of Bridgwater. Like all the central townships, the Catskill rocks, together with the glacial drift, form the basis of its soils. At East Dimock in the southern part of the township, the land is rolling and fertile and good crops are produced under good agricultural practice. In this vicinity the Cherry hill limestone is found on the surface in many of the fields, though about all of the lime has been dissolved out of the stone and only a porous lava like, brownish stone remains.

JESSUP TOWNSHIP

This township is largely drained by Forest Creek flowing out of Forest Lake, in Forest Lake township. The land in this township is moderately rolling and much of it is not as stony as in many other sections of the county in the same formation as at Fairdale and along the Forest Lake Creek where there is quite an acreage of alluvial soils well adapted to trucking; but without much of a demand for these crops it might not be wise to raise a large acreage. These soils are as well adapted for dairying as for trucking and will likely yield larger returns fromthis operation than from trucking.

Forest Lake gets its name from the beautiful lake west of its center. The township is largely drained by the Wyalusing Creek, which rises near Friendsville in Choconut township. Along the

Binghampton Road, which crosses this township, are a number of beautifully rolling farms, on the slight elevations as well as along the northern section of the township from Richmond Hill west to Friendsville located on the hills. This is an old settlement and in it are good farming soils formed from the red Catskill.

About Forest Lake is another splendid section of agricultural land adapted to all kinds of farm crops that will thrive in this section. The same is true of the vicinity of Birchardville, along the Wyalusing Creek in the southwestern section of the township. All along the ridges are the Shelly sandstone and some limy formations which is evident from the clovers and blue grass growing naturally. Dimock, Springville, Auburn, Rush and Middletown townships are very similar, except Brush and Middletown.

DIMOCK TOWNSHIP

Dimock township lies south of Jessup and Bridgwater and west of Brooklyn. This township is very similar to Jessup. In the northwestern corner, in the vicinity of Elk Lake, is a splendid section of agricultural land, which extends to and beyond the eastern boundary of the township. Here the Catskill red and grey shales form the soils, which, wherever the red predominates, the soils are more fertile.

North of Elk Lake the Cherry Hill limestone was burned years ago. The ruins of the limekiln still exist. The effects of this liming is also evident in the better crops that are still produced here. Boulders of the black limestone lie about the fields from this place to the eastern end of the township. The usual hard pan is about 2 to 3 feet below the surface. The land is moderately rolling throughout the township.

SPRINGVILLE TOWNSHIP

Springville township lies on the southern border of the county, east of Auburn and west of Lathrop. This is another of the moderately rolling townships of this county. The streams do not cut deep in the formations and therefore no very steep hillsides are formed and therefore the greater part of the land can be farmed. The Catskill rock, together with the glacial drift, form the soils which are as fertile as Catskill soils, formed from the grey and red shales, usually are.

AUBURN TOWNSHIP

Auburn township occupies the southwestern corner of the county. This townshp is more hilly than Springville. The hills are covered with sandstone forming cliffs and the soils are stony in many places.

HARMONY, OAKLAND, GREAT BEND, LIBERTY, SILVER LAKE, CHOCONUT AND APOLACON TOWNSHIPS

Apolacon township is well nigh down to the Chemung shales and has some good sections of farming land at such places as Little Meadows and some places along the Apolacon Creek and in the vicinity of Wyalusing Lake. Otherwise the township is hilly and should be covered with forest.

Choconut has a very similar formation, except Choconut Valley along Choconut Creek, where are some alluvial soils of good fertility and can be made highly profitable.

Silver Lake and Liberty are entirely within the limits of the more hilly Catskill grey and red shales, except along Snake Creek, already referred to, which is down in the Chemung shale. And while these enter into its formation, still the greater part of the valley is an alluvial soil of good fertility and will produce all agricultural crops that will thrive in this section and should be used for this purpose, because the markets would likely not justify the using of these soils for trucking. The Catskill formation is hilly along the uplands of the streams and some of it away from these, like at Cranberry Lake and moderately rolling. At Richmond Hill, on Silver Creek, the land is fertile and produces well.

Liberty township lies east of Silver Lake, along the state of New York. Snake Creek flows across the township from south to north. Along the creek the Chemung shales appear in the deep valley but do not take part in the formaion of the soil. The Lower Catskill rocks form the upland soils along and beyond the erosions of the streams, and many of these away from the stream, upland soils at such places as the upland of Rhinley Creek and south and westward to Mud Lake are fertile. In Silver Lake township are among the best hay and oat soils anywhere in the county.

Great Bend township lies east of Liberty along the New York state line. The Susquehanna River enters the township near the middle of the boundary, between it and Oakland township, and passes out of it near the northwestern corner into New York State. The township derives its name from the great curve made by the North Branch of the Susquehanna into Pennsylvania, in Oakland township, east of this township.

The soils in the valley of the river, which varies in width from a mile to two miles, are made largely of Morainic materials, derived from the local rock formation, largely Catskill, which has in many places made a fertile deluvial and some alluvial soils. In the gorge of Great Bend the river valley is only about 100 feet wide, but soon widens and forms the valley above referred to. The uplands in the southern part of the township, are hilly except near the southern township line, northeast of Summerville, in New Milford township.

Oakland township lies east of Great Bend and in it the Great Curve of the river is located. About the whole of the farming land of this county is especially adapted to apple, hay, pasture grass, potatoes, buckwheat, oats, Canada field peas, and oats raising. Alfalfa thrives in some sections.*

SULLIVAN COUNTY.

Sullivan county was formed by Act of Assembly, March 15, 1847. It contains 293,129 acres, of which 96,216 acres is land in farms, and of which 39,068 acres is improved farm land. 2,309 acres were planted with corn in 1909, yielding 62,936 bushels; 4,230 acres were sown with oats, yielding 103,142 bushels; 501 acres were sown with wheat, yielding 8,616 bushels; 2,810 acres were sown with buckwheat, yielding 42,204 bushels; 414 acres were sown with rye, yielding 5,948 bushels; 8,839 acres were planted with potatoes, yielding 70,341 bushels; 15,476 acres were sown with all forage crops, yielding 15,517 tons of the various kinds of hay. Of the 39,068 acres of improved farm land, 26,579 were used for raising farm crops, while 12,489 were not so used and were likely producing weeds. At this time Sullivan county had a population of 11,293 to feed, 8,645 cattle, 1,871 horses, 11 mules, 2,834 swine and 6,655 sheep.

This county lies south of Bradford, east of Lycoming and north of Lycoming and Columbia, and west of Luzerne and Wyoming counties. The geological formations which underly the county and from which, together with the glacial drift, the soils are derived, the Pocono sandstone, the Mauch Chunk red shale and the Pottsville conglomerate. The county is drained throughout the eastern, parts from the Chemung shales, through the Catskill red sandstone, northern and central and western parts by the Loyalsock Creek, flowing westward and southwestward and its branches, while the south central part is drained by Muncy Creek, the general direction of which is westward, and its branches, and the southeastern part by the branches of Big Fishing Creek, flowing southward, and the northeastern corner by Mahoppany Creek, flowing westward.

DAVIDSON TOWNSHIP

This township occupies the southeastern corner of the county, with the Lycoming and Columbia county lines for its southern boundary, and the Luzerne county line for its eastern. The soils of

*Read Wayne township for fuller discussion.

the township are derived from the Pocono sandstone and the Catskill red sandstone, along the streams, together with glacial drift and the rocky and stony formations pushed down from the crests of the hills and mountains. The township is high, about 2,000 feet above tide, on what is known as the Allegheny Plateau. The high Divides between Fishing and Muncy creeks pass along the northern border of this township, upon which Lake Ganoga or Long Pond is located, from which east and west the land is gently rolling, and much of it low and spouty and not well adapted for farming, but it seems that much of it could be converted into grazing land, and the remainder planted with forest trees, so as to prevent the destruction now going on there. It is very likely that some of this, and sections of the adjoining counties could be converted into cranberry marshes, and in all probability, more money made from this land than if the regular agricultural crops could be produced. This is a subject that needs further investigation. The North Mountain Plateau, lying at an elevation of from 2,300 to 2,400 feet above ocean level, has climatic conditions similar to those of states much farther north, with a flora differing from that of the valley at the foot of the mountains. This entire region was covered with a most magnificent hemlock forest, of which now only remanents remain, while the crests of the ridges were wooded with birch, poplar, beech, ash, maple and cherry, showing that this soil, though primitive, is not as poor as it is represented to be, and would at this time, with judicious forestry treatment, produce timber equal to that which grew here during the past ages. The soils of Muncy Creek Valley are derived from the soft, red Catskill rocks and some glacial debris brought down from the mountain and the hills. The land is hilly, but the soils are fairly deep, with rather poor water and fertility holding capacity, and unless judicious methods of farming are practiced wash most readily, and whatever fertility they do contain is carried away, all of which can largely be prevented by raising those crops for the raising of which these soils have special adaptations such as rye, winter vetch and oats and Canada field peas, as combined soil improving and soil exhausting crops, with which the clovers—red, alsike and Mammoth, and probably alfalfa can be sown.

A ten rowed flint type of corn could readily be developed, adapted for this section with which could be sown timothy and the clovers sometime the beginning of August and a sod for hay started. These soils are well adapted for wheat and hay raising, especially timothy, of which they will produce fairly large yields of a fine quality. It seems that in the Catskill soils or in the soils largely derived from the Catskill rock, especially the red Catskill, the Northern Spy apple finds a more congenial soil environment than in any other, and produces larger yields of a highly colored, nicely flavored fruit. Whether

this elevation is as well adapted for fruit raising as others probably needs further demonstration, but it seems that with a series of crops that will supply organic matter, rich in nitrogen, to produce wood growth sufficiently vigorous to endure more rigorous climatic conditions, the apple raising industry of that apple, of all apples, the best, the Northern Spy could be made an inviting proposition. In the gorge of Fishing Creek is a massive limestone vein, 12 feet thick, which when burned slakes well, which it seems could be ground and applied to these soils, which they need very much and splendid results obtained.

COLLEY TOWNSHIP

This township lies north of Davidson, with the Luzerne and Wyoming county lines for its eastern boundary. The soils of the township are derived from the Catskill red sandstone, the Pocono sandstone, a probable narrow strip of Mauch Chunk red shale and the Pottsville conglomerate. The township lies fully 2,000 feet above tide, with climatic conditions not favorable for raising many of the agricultural crops such as corn, wheat and many of the clovers. The soils are fairly deep and in the southern and central parts moderately rolling, with considerable areas of land, low and wet especially in such places where the divides of the streams occur, and in the vicinity of the lakes such as Long Pond or Ganoga Lake previously referred to. It is likely that some of these areas could be converted into cranberry marshes, and inviting returns realized. The Loyalsock Creek, and its branches, make deep gorges in the central part of the township along which there is little or no farming land.

North of the central part of this township the Bernice coal basin remains surrounded with the Pottsville conglomerate, making a rough, rocky and stony country, with little farming land, except in some small sections, where the soils are derived from the coal shales. Big Mountain lies south of Mahoppany Creek, and makes a rough and rocky country with little or no farming land. In the northern part of the township at Valley, and its vicinity some hilly farming land occurs, with fairly deep soils derived from the Catskill red sandstone, together with some glacial remains produced by the scouring action of the glacier which has rounded the hills and made farming operations more easy, with a more productive soil, which here will produce the crops referred to in the discussion of Davidson township.

CHERRY TOWNSHIP

Cherry township lies directly west of Colley, along the Bradford county line. The soils of the township are derived from the Chemung shales, the Catskill red sandstone, the Pocono sandstone and the Pottsville conglomerate. The Bernice coal basin lies in this town-

ship, with soils derived from the Pottsville conglomerate, which are rough and stony, with only such agricultural areas referred to in Colley township. North of this formation, the soils are derived from the Catskill red sandstone which begins to widen near the eastern border of the township, and at Dushore, is approximately four miles wide, making a hilly section with fairly well rounded hills, with fairly deep soils, with rather poor water and fertility holding capacity, especially adapted for raising the Northern Spy and Baldwin apples, and timothy hay. The Chemung shale soils in the northern and northwestern part of the township are the most fertile in this county, and are splendidly adapted for raising timothy hay, rye, wheat, flint corn, Canada field peas and oats, and among the legumes, beside the Canada field pea, the red and alsike clovers, and in the deeper soils alfalfa, when carbonate of lime is applied. The more stony of these soils seem especially adapted for raising the Baldwin apple of which it will produce fairly vigorous trees, which yield fairly large crops of highly colored, nicely flavored fruit.

FORKS TOWNSHIP

This township lies west of Cherry. Near the western border of this township, at Forksville, the two branches of the Loyalsock Creek meet here. Several miles north of this place along Mill Creek, whether in this or Elkland township, a limestone crops out of which the following two analyses give the composition of the upper and the lower layers.

	Upper.	Lower.
Carbonate of lime,	80.393	69.000
Carbonate of magnesia,	5.653	5.387
Carbonate of manganese,	3.116	1.689
Sulphur,	0.240	.092
Phosphorus,	0.133	0.144
Oxide of alumina and iron,	5.196	5.870
Insoluble residue,	5.240	17.850
	99.971	100.032

The upper layer of this limestone, when finely ground, will supply all the lime needed by both the Chemung, Catskill and glacial soils throughout this section, and will produce on these soils equally as good results as the burned lime would, but probably not quite as quickly. The lower layer will give splendid results when applied in large quantities. The soils of this township are derived from the conglomerates, Poconos, Catskills and Chemung formations. The southern half of this township is rough, rocky and stony, with little or no farming soils. The soils derived from the Catskill red sand-

stone are stony and hilly, adapted for apple raising, while the soils derived from the Chemung rock make moderately rolling country with deep soils, with fairly large water and splendid fertility holding capacity. The Chemung soils of this section are among the most fertile and easily farmed crop accommodating, warm for this section, early spring farming soils, derived from this formation anywhere in the State. In the vicinity of Campbellville is such a section, adapted for raising all the regular agricultural crops that thrive under prevailing climatic conditions.

ELKLAND TOWNSHIP

This township lies west of Forks on the Bradford county line. The soils are derived from the Chemung, Catskills and the Pocono rock, with some glacial drift. The Chemung formation comes in from the much larger area of soils derived from these strata in Forks township, and makes a moderately rolling country, with soils similar to those previously discussed, with similar capacities and adaptations.

FOX TOWNSHIP

This township occupies the northwest corner of this county, with the Bradford county line for its northern and the Lycoming county line for its western boundary. The soils of the township are derived from the Catskill and the Pocono rock. At Fox Center and vicinity is one of the fertile Catskill red soil sections, where considerable farming is done. This, like the soils of this formation in the townships previously discussed, will produce the agricultural crops, as well as, apples and some of the clovers which can be used for improving the soils. In the southern part of the township the soils are derived from the grey Catskill sandstone and the country is rugged and mountainous, with only small areas of farming land, all of which would likely better be in forest.

LAPORTE TOWNSHIP

This township occupies about the central part of this county, with Laporte, the county-seat of the county, located in the western part of this township. The soils of the township are derived from the Catskill, the Pocono and the conglomerate rock. The southern part of this township extends into the valley of Muncy Creek, in which the soils are derived from the Catskill shales and red sandstones, and are similar to the soils discussed in Davidson township. On the flat hill top on which Laporte is situated, is some farming land derived from the lower layers of the Pottsville conglomerate and the Pocono sandstone, not fertile but with good agricultural practice will produce fair crops of hay and rye, oats, and with some lime, the clovers. Elsewhere the land is stony and rocky and difficult to farm.

SHREWSBURY TOWNSHIP

This township lies west of Laporte, south of Forks, with the Lycoming county line for its southern boundary. The soils of this township are derived from the Catskill and conglomerate strata. The soils of the southern part of the township are derived from the soft, red Catskill shales and at Muncy Bottom and northward, southward and westward from this place are deep, with fairly large water and fertility holding capacity adapted for raising the pasture and hay grasses, as well as, corn, wheat, oats, rye, buckwheat, potatoes and the legumes, among the short season, the winter vetch, the Canada field pea, and among the long season, the red and alsike clovers and alfalfa. These soils need lime and manure with some phosphoric acid and good cultivation. Eaglesmere, quite a noted summer resort, situated on Lewis Lake, is located in this township, and affords a ready market for all market garden products that can be raised in this valley. North of this section, the land is rough, penetrated by deep gorges cut into the Pocono sandstone, which are separated by narrow Hogback Ridge with no farming land.

HILLSGROVE TOWNSHIP

Hillsgrove township lies west of Shrewsbury and south of Fox and Elkland, with the Lycoming county line for its western boundary. The same rugged country, discussed in the previous township, continues in this township with the same soil formation, with little or no agricultural land, except in the northwestern part where the Catskill red sandstone comes to the surface and makes a less steeply hilly country, with fairly deep soils adapted for raising the same crops as similar soils previously discussed. The agriculture of this county needs to be more definitely studied and methods of cropping worked out by means of which the land can be improved in crop yields and increased in fertility.

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*BRADFORD COUNTY

Bradford county contains 732,800 acres, of which 623,303 acres is land in farms, and of which 458,637 acres is improved farm land. 15,070 acres were planted in corn in 1909, yielding 386,453 bushels; 40,316 acres were sown with oats, yielding 717,090 bushels; 4,207 acres were sown in wheat, yielding 72,168 bushels; 27,560 acres were sown in buckwheat, yielding 498,758 bushels; 6,692 acres were sown in rye, yielding 80,524 bushels; 7,336 were planted with potatoes, yielding 705,214 bushels; 278 acres were planted with tobacco, yielding 328,752 pounds; 132,011 acres were sown with all forage crops, yield-

*Bradford was formed from part of Lycoming and Luzerne February 21, 1810. This county was called Ontario previous to March 24, 1812, on which date it was changed to Bradford.

ing 160,182 tons of the various kinds of hay. Of the 458,637 acres of improved farm land, 233,470 were used for raising farm crops, while 225,167 were not so used and were likely producing weeds. At this time Bradford county had a population of 54,526 to feed, 68,317 cattle, 14,338 horses, 149 mules, 19,865 swine and 19,781 sheep.

THE SOIL FORMATIONS OF THE COUNTY

Bradford county borders on the State of New York, and is the third of the northern tier of counties beginning with the northeast corner. The geological strata which outcrops in this county, and together with the glacial drift, which covers a large part of the county and have formed the soils, are the coal measures and conglomerates, a small amount of Mauch Chunk red shale, some Pocono sand, considerable Catskill with a large territory of Chemung.

The county is drained by the North Branch of the Susquehanna River, which enters it from New York State about midway along its northern boundary. The Chemung River joins the Susquehanna about five miles south of the State line near Athens. Wyalusing Creek drains the southeastern, Wappasening the northeastern, Towanda Creek the southwestern and Sugar Creek the central and northwestern sections. This county, with the exception of the southwestern townships, is an open, rolling county with a larger acreage of soils adapted for farming than any of the counties in this section of the State. It has had the reputation of being the largest butter producing county of this or any other state, which is only a natural result of soil adaptation and the taking advantage of such adaptation. Southern Wyalusing, Tuscarora, Perry, Wilmot and Albany townships have the same formations and are very similar in the mineral construction of their soils. Tuscarora and Little Tuscarora Creek and their branches flow through Tuscarora township from north to south, and like all streams in this section, there are some steep hillsides along their courses but the upland is rolling and easily farmed at East Spring Hill and Spring Hill.

The hills of southern and central Wyalusing, northern Tuscarora and southern Pike are formed by the disintegration of a reddish rock which contains carbonates and forms a better soil than normal, which is evident from the vegetation, especially the forest. Along the Wyalusing Creek, near the village of Wyalusing, and further northeast, large masses of limestone lie about the fields similar to the limestone bed at Burlington, along Sugar Creek, to be discussed later. The good effects of the disintegration of these isolated limestone, lying about on the soil, are noticed in the more luxuriant plant growth wherever these are found showing that these stone contain the essential elements to make these soils more productive. These stone occur further north along this creek until the northern part,

but especially the northeastern corner of Tuscarora township is reached, when the formation crosses into Susquehanna county. Wilmot, Terry and Albany townships are made up largely of rolling upland containing a number of ponds or shallow lakes, such as Stowell's Pond, Little Pond, Wells Pond and other one time lakes or ponds now become dry land, some of which make the best type of grass and trucking soils. This rolling formation extends north to the Barclay Mountains and south to the Tunkhannock Mountain and crosses the Susquehanna and stretches over most of Tuscarora, parts of Wyalusing to the north and south into Wyoming and Sullivan counties. This is one of the grass sections of these counties. Apples will do very well here on the higher elevation. Potatoes are raised in the more gravelly soils, while buckwheat, rye, corn, and wheat, of which little is raised, yield good crops in the loamy and gravelly types.

Monroe, Overton, Barclay, LeRoy and southern Canton contain the coal measures of Bradford county, the Mauch Chunk red shale, or a red shale of the Pocono and the Catskill formations, all of which means that there is some rough and mountainous land in this section. At Monroetown, in northern Monroe, the soil is level throughout the valley of the Towanda Creek and moderately rolling on the elevations above the bottom land, a condition that continues across toward the river. Here glacial action and glacial deposit predominates in the soil formation, especially in the valley and along the slopes of the hills, until in the vicinity of Powell where the valley widens and the Monraine materials disappear and the uplands north and northeast of this place become more moderately rolling, because the red shale already referred to predominates in the formation of the soil. Some distance south of this place, toward Weston, the Pocono formation appears and with it a rougher country with narrow and steeper valleys covered with stones and outcropping rocks, fit only to grow forests of pine, hemlock, beech and birch and maple which it is now endeavoring to do and would do if it were not burned over and over well nigh every season and trees cannot grow.

At Barclay, in Barclay township, the coal formation, conglomerate, red shale, Pocono, and Catskill formations outcrop and the higher of these form the soil which is only adapted for forests. The same thing is true at Loquin, a lumbering and mining town of small size. On top of the Barclay Mountain the rolling Pocono formation, so prevalent in the uplands of Monroe and parts of Carbon county, prevail, except that it is less extensive and is less swampy. In the vicinity of Wheelerville, southeast of this place are some apple orchards which look thrifty and produce fruit. The feasibility of apple growing here has not been fully determined but it seems that this fruit will do well here.

All except the northern part of LeRoy township is in the same formation as Barclay and, therefore, needs no further discussion. So is also southeastern Canton, except that here the Pocono and Catskill together occupy a considerable territory, and wherever these two unite in the formation of the soils, they are more fertile than where the Pocono is the only rock entering into the formation.

The soils of Armenia township are similar in derivation to the soils of Barclay, because here Armenia Mountain, made up of the same rock formation, enters Bradford county in the southwest corner of Columbia township, turns south, keeping along the line between Troy and Armenia townships back into Tioga county. So that, therefore, the soils are derived from the coal formation, the red shale and Pocono. This mountain makes a precipitous wall along the eastern line of Armenia township and a very stony and rocky soil, fit only for forest in well nigh all sections.

The Chemung rocks make the soils of northeastern Canton township, all of Granville township, the southern parts of Troy and West Burlington, all of Burlington, except a narrow section in the northern part, all of North Towanda and South Towanda, all but the southwestern part of Asylum, all of Wysox, except the narrow section in the north, and the whole of Standing Stone. The parts of these townships not covered by Chemung rocks, together with Herrick and Pike are included in the doubtful region of Chemung-Catskill transitional beds. They have soils of a superior fertility.

The higher lands of eastern Canton, Granville, West Burlington, Burlington and Towanda townships form the divide between Towanda and Sugar creeks, and as usual, these higher lands are rolling and better adapted for farming, than the steeper hillsides, which, in the Chemung formation, wash readily unless they contain a large amount of vegetable matter which at the present time few of these soils contain. These uplands are well adapted for hay and roughage, and when well farmed, will produce large crops of wheat, except where the glacial hard pan comes close to the surface. Here it is best to raise shallow rooting crops such as timothy and as frequently as possible, plow down a heavy sod.

Beginning west of Troy, in Troy township along Sugar Creek and the elevated lands, the soils are made of the Catskill formation and are reddish in color and are better adapted for the raising of cereal grains than the Chemung soils. Along the creeks is a large acreage of glacial and alluvial soils, well adapted to farming, especially dairy farming, because here, by the adoption of a succession of crops by means of which several clovers can be raised and a heavy sod plowed down and the direct application of manure to the soils as it is made, both the roughage and the grain ration for dairy cows can be raised. A considerable acreage of this soil is used at the present time, and

more has been used in the past for raising tobacco. The tobacco is said to be of good quality. These soils made up as they are of the deposits of glacial action and river alluvium are of superior fertility and there is no reason why a superior quality of tobacco should not be raised here.

Beginning some distance east of East Troy, a fossil, containing limy formation, appears on the hillside north of Sugar Creek until, West Burlington is reached where, east of this town a definite fossil limestone crops out along the road. East of the town of Burlington this limestone formation, especially the lower strata, are of a reddish color and seem to be made up entirely of fossil shells. The whole stratum must be 40 or more feet in thickness. This stone was burned in an old style wood burning limekiln years ago, and from the reports of those who know about it and have used the lime, it is learned that it makes a strong lime of rather a dark gray color well adapted for agricultural purposes. *The following analysis gives the composition of the stone:

Lime,	41.04
Magnesia,	1.13
Sesquioxide of iron,	4.28
Alumina,	2.63
Sulphuric acid,	0.167
Phosphoric acid,	0.279
Carbonic acid,	33.24
Insoluble residue,	18.01
	100.775

This limestone formation is so located that the kilns could be built at the foot of the hill, close enough and high enough to load the lime from the mouth of the kiln directly on cars or wagons, and the stone could be brought by a chute from the breast of the quarry to the top of the kilns with but one handling.

But what is still better, wherever this same limestone disintegrates, lying on the fields, there the vegetation grows more luxuriant, showing that the carbonate of lime, even through the slow process of disintegration, has a salient effect in these soils, and as such is the case finely ground limestone will have an equally and even more beneficial effect and, therefore, the probabilities are that the only operation necessary to get the desired results would be to finely grind this stone and apply it to the soils of Bradford county. There is enough limestone in this formation to lime all the agricultural soils of the county a number of times. This same formation, with its beneficial effects, is noticeable along this stream to within a few miles west of

*Second Geological Survey of Pennsylvania, Vol. 9, Page 38.

Towanda, when it either changes its course or subsides. At Luther's Mills and vicinity the land is less hilly and the soil fertile as is shown by the natural vegetations and the timber which here is largely oak, hickory and chestnut as it always is in the limestone formation already described.

The valley of Towanda Creek, flowing through the same formation as Sugar Creek, because of the Barclay Mountain, has the Catskill formation on the south side of the creek instead of the north side, except in Franklin township, where the Catskill occupies both sides of the Towanda Creek and, therefore, both these formation, together with limy fossils which occur here in such abundance that it seems the entire rock is made up of them, enter into the formation of the soils and make it more fertile. In a number of places along the valley of this creek, the Chemung shales are limy and, therefore, make a more productive soil.

North Towanda and Towanda townships contain a large acreage of moderately rolling farming soils along Sugar Creek as it approaches the river. The same is true of Towanda Creek and along the river where these creeks enter it they have formed some of the best river soils in the State adapted for all kinds of farming, but especially for dairying trucking. Here all the ingredients of the fifty-seven could readily be produced.

Wysox township east of the Susquehanna River and west of Towanda, contains a large section of the river formation of soils, already referred to, especially in the vicinity of the town of Wysox. Here are soils that will produce all crops that thrive in the prevailing climatic conditions. Some good farming is being done here. As much as three tons of hay are being raised per acre and sixty and more bushels of oats and a very fair yield of corn is also produced. There are hundreds of acres of land equally as fertile as the plains of Wysox but are not farmed as well and, therefore, do not yield the crops.

Standing Stone township has some of these river soils of the same fertility. The remainder of these townships, including Herrick and Pike, come within the limits of the questionable formation. These upland soils are more fertile than are the soils formed from the definite Chemung rocks, because limy formation occur in their strata, as along Rummersfield Creek, where the gray shales contain the limy fossil shells. At Herrick, in Herrick township, these same formations prevail, together with a reddish sandstone, which contains the bands of the fossil bearing limestone, which are similar to the Burlington limestone.

At LeRoysville, in Pike township, the red soils occur and also the Burlington limestone, apparently of the same composition and can be made into lime as readily as at Burlington, or ground as easily and applied to soils of the Chemung formation in this and other sections of the county.

Southern Herrick and Pike townships and nearly all of Standing Stone, are of the Chemung formation and have many acres of rolling upland well adapted to raising hay and oats and potatoes and silage corn and the Ninety Day varieties of corn for grain. Here, as in well nigh all these northern counties, a Ninety Day type of corn should be developed for highest yields. With the cacapity of these soils for growing sods, there would be no difficulty in raising a sufficient quantity of corn, oats and buckwheat to carry through the winter a large herd of cows and make the operation profitable.

Northern Pike and southern Orwell, northern and southern Rome, southern Warren, Windham, Litchfield and Athens are in the transitional Catskill and Chemung. Along the Wysox, on the hills north of Myersburg in the vicinity of the Little Lake, of which I was unable to ascertain the name, are rolling formations of the Chemung and Catskill, making good soils. Further north and northeast on the hills, in the vicinity of Rome and north of this place the same formation continues, on to Orwell Hill and north Orwell in Orwell township. On Orwell Hill, the lava like disintegrated Shelly limestone, from which about all the lime has been dissolved is seen lying about the fields. Whether this formation has any body here was impossible to determine but its effects are visible. From Orwell Hill to North Orwell is a rolling formation of good quality. This sweep of land continues eastward through North Pike township by LeRoysville and north of this place into Susquehanna county where the Catskill formation covers the entire county. In the vicinity of LeRoysville, the Burlington limestone, as already stated, crops out and exposes such extensive strata that it seems a paying business could be made of quarrying and preparing it for agricultural purposes. In southern Warren township, where rises the Wappasening Creek, along the ponds and small lakes, is a rolling formation extending north and east from South Warren Postoffice to Warren Pond covering about the entire township to the east branch of Wappasening Creek and Warren Center. From this section northward a reddish rock formation again appears and enters into the composition of the soils, especially of the higher elevations in the vicinity of Warrenham, north, northeast, southwest and south of this place. This makes a soil here that responds well to cultivation. Corn stubbles plowed in the fall can be prepared for seeding with oats

considerably earlier than when allowed to lie until spring. In fact it is said it can be plowed a second time before land that was not fall plowed is dry enough for plowing.

Southern Windham and Litchfield townships have the same formations, and therefore, similar soils. From Athens east along the Susquehanna, along what I might term Athens Hill, the shaly limestone formation outcrops on the top of this hill and lies about in large boulders the salient effects of which are manifest in the oak, hickory, chestnut and other hard wood trees which covers the side of this hill facing the river. From this place eastward the divide of the stream are rolling and make the best kind of grazing soils while the slopes which face north and northeast are usually steep and make poor farming soils, those facing south and southwest are moderately rolling and furnish some very good soils. Athens in Athens township, east, west, north and south of this town are the river soils. The section between the Susquehanna and the Chemung rivers is especially fertile and adapted to all kinds of crops that will grow in this climate but it seems should be used for dairying and for trucking, what still remains outside of the towns of Athens and Sayre. The River Valley of the Susquehanna throughout this county even in the narrow places, wherever there is any extensive soil deposit, is very fertile as already stated. In Sheshequin and Ulster and North Towanda township where Towanda Creek flows into the river and where the Catskill formation remains and forms the soils on the uplands, along the river and, therfore, also to a large extent, the soils along the river valley, here are soils not surpassed any where in the State, in a similar formation, and would if farmed with a succession of crops adapted to these soils produce an average of twice as much as they now do.

All of western Ulster, southern Smithfield, northern Burlington and West Burlington, southern Springfield, nearly the whole of Troy and southern Columbia townships is a hilly country with soils formed by the disintegration of Catskill rocks. This is the section of Bradford county in which fruit growing and farming, such as Wyoming and Susquehanna counties do and which can easily be worked out for this section, and should be done. A few high mountains occur here, one on the line between Springfield and Troy townships, known as Mt. Pisga, from the height of which, this and surrounding counties can be viewed. It is the eastern end of Armenia Mountain with which it was at one time connected.

Athens, Ridgebury, South Creek, Wells, northern Columbia and Springfield townships are located entirely in the Chemung formation, and the soils are formed by the disintegration of these rocks. These townships are a continuation of the formation of the Wellsboro and Mansfield Valley, of Tioga county, but are more steeply hilly, with

soils that wash more readily and are also more elevated. On the highlands along the Chemung River where it curves into Pennsylvania, are nicely rolling soils between the divide of the streams flowing into this river. This condition continues on to Smithfield and along the divide between Betley and South Creeks, in Ridgebury and South Creek townships.

At Moiserville, or Seeley Creek, all the uplands along between this stream and Roaring Run are rolling as well as further south as far as Old Hickory where are some ridges of Catskill. From here on the streams flow south into Sugar Creek and more hilly country is encountered.

TIOGA COUNTY

Tioga county was organized by an Act of the Legislature, March 26, 1804, taken from Lycoming. It contains 730,880 acres, of which 475,471 acres is farm land, and of which 293,011 acres is improved farm land. 5,628 acres were planted with corn in 1909, yielding 150,418 bushels; 31,515 acres were sown with oats, yielding 620,695 bushels; 866 acres were sown with wheat, yielding 16,155 bushels; 16,962 acres were sown with buckwheat, yielding 225,717 bushels; 588 acres were sown with rye, yielding 9,025 bushels; 4,622 acres were planted with potatoes, yielding 383,874 bushels; 761 acres were planted with tobacco, yielding 845,957 pounds; 107,805 acres were sown with all forage crops, yielding 128,340 tons of the various kinds of hay. Of the 293,011 acres of improved farm land, 168,747 acres were used for raising farm crops, while 124,264 were not so used and were likely producing weeds. At this time Tioga county had a population of 42,829 to feed, 50,942 cattle, 10,688 horses, 58 mules, 11,151 swine and 27,880 sheep.

THE SOIL FORMATIONS OF THE COUNTY

The rock strata outcropping in Tioga county, from which through the agencies of disintegration and from glacial drift and by glacial action, the soils have been formed, begin with the coal measures and the conglomerate in a few of the southeastern townships, followed by the Pocono sand in the same and the central and northwestern sections, while the extreme southeast corner, the central and the whole of the northern townships are formed of Catskill and Chemung shales.

The southeastern parts of Union and Liberty townships, in the southeastern section of this county, is the continuation of a less rough and rocky section of land than that surrounding it, which

begins in Jackson township, Lycoming county, upon which the soils are formed from the Catskill shales and sandstones. This is a high but moderately rolling formation which has been and is still being farmed and produces well all crops adapted to this elevation and to the soils, especially apples wherever trees have been cared for.

CHARESTON TOWNSHIP

In this Township the Chemung formation is narrower than the Delaware and the Catskill much more extensive especially at such places as Cherry flats, south of east Charleston as well as in the northern section of the township. This is a moderately rolling country well adapted to farming, especially the grass or hay and pasture crops.

RICHMOND TOWNSHIP

Richmond township contains the largest acreage of the Wellsboro and Mansfield valleys, the soils of which are made up of Chemung and Catskill formations and cover all but the extreme southern section and the northwestern corner and are making this township one of the richest agriculturally in the county. At Covington the land is more level in the valley than any other section of the county and is better adapted to farming and more easily farmed. Here the Catskill and the Chemung together form the soils and usually make it more fertile Further south of this place the county becomes more hilly as the Pocono formation is approached. There is considerable danger in these soils from washing, because when they become saturated with water unless they contain a large amount of vegetable matter, they will wash and not only wash but in some places, a creeping down the hill sides has begun and unless this is stopped the most disastrous results may follow. North of Covington at Canoe Camp, the land is moderately rolling and fertile especially adapted to growing the grasses.

The Mansfield Valley, which is one of the richest in the county, has soils well adapted for cereal crops such as oats, corn especially the flint varieties and silage corn which yields a large amount of forage. Alfalfa, Canada field peas and oats do well here. Seeding the Canada field peas and oats with grass does remarkably well in this section. Some distance from Mansfield, probably three miles, near the road to Wellsboro, occurs a bed of limestone or limy rock. Some six feet in thickness which was used years ago for flux in the iron furnace at Mansfield and was also burned into lime and used for agricultural purposes.

Another outcrop of this same limestone occurs two miles north of Mansfield, having the following composition:

Lime,	28.87
Magnesia,	1.17
Alumina,	2.26
Sesquioxide of iron,	2.14
Sulphoric acid,	0.08
Phosphoric acid,	0.72
Carbonic acid,	23.22
Insoluble residue,	41.70
	100.16

This outcrop is sufficiently large to merit investigation and likely development especially in this community where lime is needed and if gotten from out of the county requires transportation for quite a distance. But what makes it still more valuable, the coal for burning lime is within easy reach of the limestone and can be gotten cheap so that the burning of lime should be a omparatively inexpensive operation, and with the demand for lime such as a progressive agricultural should create, a large amount could be disposed of here.

SULLIVAN AND RUTLAND TOWNSHIPS

Sullivan and Rutland townships form the northern extremity of the Wellsboro and Mansfield Valley. While this valley continues into Bradford county, and to a certain extent onward into New York State, the land becomes more hilly, more liable to wash and is less adapted to moderately rolling land farming but more to hilly land farming. Throughout this entire valley is a large acreage of soils well adapted for fruit raising, apples such as the Northern Spy, the Baldwin, the Greening, and Stamen Winesap. This latter seems to do well here. Northern Rutland, southern Tioga, southern Middleberg, northern Delmar, nearly all of Shippens as already intimated lie within a band in the underlying rock in which is preserved the Pocono sand. This country is not as thickly settled because the land is not as well adapted to farming. North of this Pocono section, the Catskill and Chemung formations cover the surface of all of Jackson township, except a border on the south, the northwest third of Tioga and Middleberg townships. All of Lawrence, Farmington, Nelson, Elkland and Osceola, all of Chatham except the southern border, the southeast corner of Deerfield and Westfield township and all of Clymer but the southern border.

The valley of the Cowanesque Creek lies in these townships, extending for a distance of approximately twenty-five miles from the Potter county line to and beyond the Tioga River, varying in width from six miles at its western end to ten miles in Farmington township, of which it covers the entire surface including the northern part of Middleberg. This is one of the best Chemung soil farming sections

of the State. The land is rolling with low rounded hills making agricultural operations easy. The soils are loams with some stones but not too many for farming as done here. As a whole the practice is not such that will cause the soils to produce what they are capable of yielding. Some of the streams in this section cut deep into the formation and have precipitous banks only adapted to forests, while the uplands, with the exception of a few sections along the streams are farming soils as well as the fruit soils.

Northern Union, northern Liberty, nearly all of Morris, except the creek valleys, a large part of Elk, the whole of Ward, Hamilton, Bloss and Duncan, with southern Covington, are located in what is known as the Blossburg coal basin. The mountains enclosing this basin are capped by the massive conglomerate rock and are so rough and stony that no farming is being done here so far as could be ascertained. The sides of the mountain, both north and south of this basin, are steep slopes down to the valleys of the surrounding Catskill formation, while on the inside of this basin, at such places as Fall Brook, Morris Run, Blossburg, Arnot, Antrim, Hamilton, Duncan and at Morris, a small town at the end of the basin, the hills are not so high but rugged, covered with massive rocks and stone of the lower coal measures making farming a precarious undertaking. The market here is good because considerable mining is being done but the products should be raised outside of this basin in the more fertile sections of the county.

Morris township which is largely covered with the Pocono sand, is very hilly especially along the streams such as Bobbs Creek, Stony Fork and Pine Creek. At Blackwell and vicinity, the uplands away from the precipitious gorges of the streams can be farmed. At Tiadaghton the hills become more rolling, glacial action having done more work. Oak and chestnut timber comes in along the hills and the soils are more fertile. The uplands here are being farmed. This more productive soil is the result of the bringing up of the rock lower than the Pocono by an upward bend in the formation which begins in the southwest of Elk township and crosses Cedar Creek and Pine Creek flowing in a northeasterly course. At this place rock is exposed containing fossil shells such as were observed along Sugar Creek in Bradford county. These rocks are somewhat dark in color and contain lime and carbonates which causes the oak and hickory timber to appear.

With this formation begins one of the most fertile districts of this county. It includes southern Shippen, southern and central Delmar, nearly all of Charleston, except the southeast corner, all of Richmond and of Sullivan, but the southern sections and also the southern part of Rutland. On the south side of this formation the Pocono sandstone forms a rough, and in many places, precipitous stony and

rocky soils, as already indicated, of little value for farming. The Pocono formation to the north is not as rugged except in Gaines township east and west of Long Run. At Ansonia, in Shippen township, where Marsh Creek flows into Pine Creek to the northeast, the country becomes rolling, but to the north it continues hilly and also to the south, but the valley becomes wider and the hill recedes northward until at Marsh Creek, a small place along the railroad, the valley has widened toward the east, southeast, and southwest, and a large acreage of black muck soils have been formed out of what likely at on time was a lake bottom or marsh. Celery, onions and similar vegetables, of a superior quality are being raised in large quantities here and still more could be raised if all the soil adapted to these crops would be used for this purpose.

DELMAR TOWNSHIP

The surface of this township, with the exceptions already indicated is rolling especially the Wellsboro Valley and the vicinity of Wellsboro, the county town, which is surrounded by a succession of hills from which flow several small streams into Marsh Creek which flows by the town. This is one of the fertile valleys of the county, and may be considered among the best soils of the Catskill and Chemung formations anywhere in the State. Limestone strata occur in the quarries near Wellsboro, especially in the hill back of the county house where numerous bands interstratify a fossiliferous formation many feet thick. This formation, factored in the production of the soil, as is shown by a bed of bog limestone (Traventine) formation, along the road south of the town, where in a large dry bog covering considerable space this limesone occurs and from which it has been taken and burned into lime of fine quality. In this township (Delmar) a salt well was bored some 300 feet deep from which it is said a considerable stream of water pretty strongly impregnated with salt is flowing. This is in the southern part of the township, near where the Chemung and Catskill outcroppings unite. From Wellsboro south to Stony Fork covering the entire township between these two places are the Chemung rocks.

CHARLESTON TOWNSHIP

In this township the Chemung formation is easily worked. Some clay soils occur in the lower sections but they are not extensive. In this section or valley all the cereal grains can be raised including wheat. This kind of farming should be encouraged here, and a rotation adopted that would include these grains. This valley extends east to and beyond the Tioga River. The land is more hilly and not so easily farmed southwest of Lawrenceville on into Farm-

ington township. Northward the valley becomes wider, and along the streams are some alluvial soils splendidly adapted to truck farming. In Jackson township the same Chemung formation continues, but the land is hilly and some, difficult to farm, but usually the uplands are rolling and well adapted to farming. The town of Tioga, in Tioga township is located on a river bottom of glacial and river alluvium of good fertility. At Tioga Junction is another of these formation which, however, is well nigh entirely glacial, with a Moraine at the foot of the hills, while as the uplands are reached the underlying rock predominates in the soil formation. At Jackson Summit the land is nicely rolling, but in some places underlaid with hard pan, and, therefore, not as fertile and productive. Jackson Center is surrounded with good agricultural land; so is Jobs Corners, still further south, all land adapted to growing grasses, oats, potatoes and buckwheat.

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